Fly Ash: Basics, Beneficial Reuse and Pending Regulation

CALSTAR PRODUCTS

What is Fly Ash?

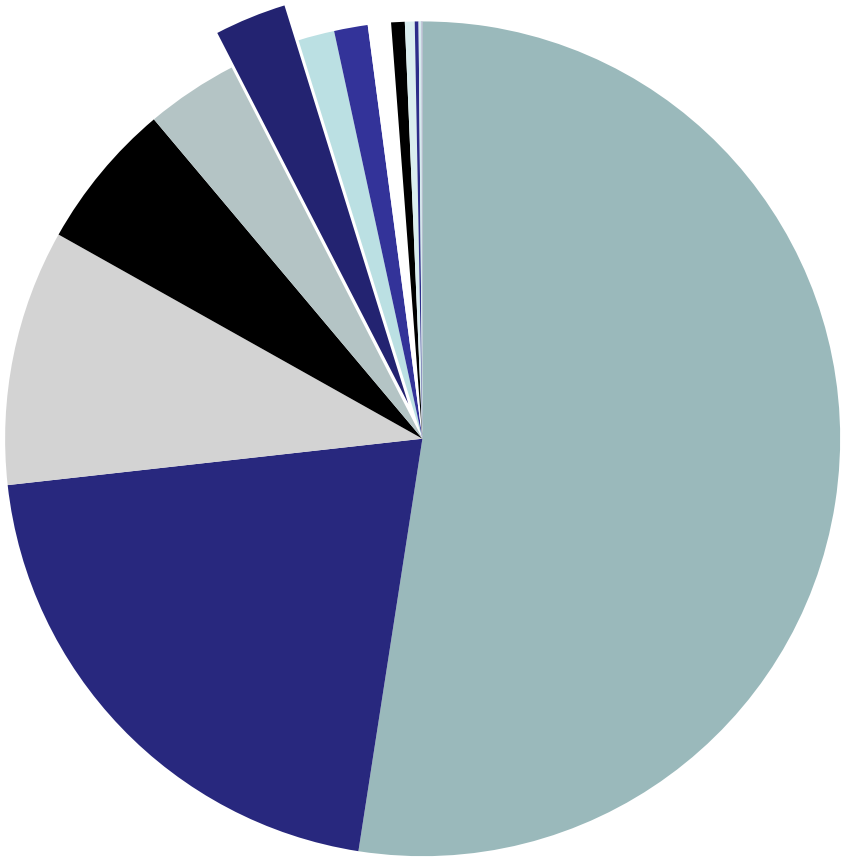
- Coal-generated power
  - Provides ~ 50% of US power
  - Coal is fed into a boiler to combust and provide power
  - 5-10% of the coal does not get completely incinerated
    - Most of the remaining material is so light, it would “fly” out of the smokestack, if not captured
      - This is fly ash
    - Remaining material too heavy to fly away and falls to the “bottom””
      - This is bottom ash
    - 80% of non-incinerated coal is fly ash

Is Fly Ash Toxic?

- No: EPA specifies one method for determining toxicity
  - EPA SW846 Method 1311 *Toxic Characteristic Leaching Procedure* (TCLP)
    - Simulates municipal solid waste landfill exposure (more aggressive than construction and demolition landfill)
    - Grind up sample into pea-sized chunks
    - Expose to combination of hydrochloric acid, nitric acid, sodium hydroxide, and acetic acid (depending on specified test conditions)
    - Determine what, if anything, leaches out
    - If concentration of leachate is below EPA-mandated threshold, material is not toxic

Fly Ash End Use

2007 USA Supply - 75M Tons



Source: American Coal Ash Association

Fly Ash End Use

- Disposal
  - Landfill
  - Wet ponding (not desirable)
    - TVA fly ash pond disaster (structural failure)

- Beneficial reuse
  - Partial cement replacement in concrete
    - For every ton of fly ash used, removes 1 ton portland cement, avoids nearly 1 ton of CO_2 emissions
  - Other construction products
    - Structural fill
    - CalStar products (more later)

Fly Ash Concrete End-of-Life

- Fly ash is incorporated into cement matrix
  - Becomes part of the concrete
- Fly ash concrete demolition
  - Poses no additional concern beyond the demolition of concrete that doesn't contain fly ash
    - i.e. Always wear safety glasses, dust masks, and other PPE
  - Fly ash concrete particles will be about the same size, and have same constituents as particles of concrete with no fly ash
    - Fly ash and cement have the same general ingredients, just in different proportions
    - Fly ash and cement combine integrally when mixed in the concrete

Is Fly Ash Toxic? cont.

- EPA Toxic Characteristic Leaching Procedure (TCLP) test for 8 metals
  - Tests for Ag, As, Ba, Cd, Cr, Hg, Pb, Se
- California tests for 9 additional metals
  - Be, Co, Cu, Mo, Ni, Sb, Th, V, Zn
- CalStar tests for all 17

- CalStar products pass TCLP with flying colors
  - Leachates at least 10x lower than EPA levels of concern

Fly Ash: Broad Acceptance

Fly ash used broadly as a building material in many uses such as the Hoover Dam, built in 1931

25% fly ash

50% fly ash

Freedom Tower, NY

50% fly ash

De Young Museum, SF

NRDC
THE EARTH'S BEST DEFENSE

EARTHJUSTICE
Because the earth needs a good lawyer

NRDC
THE EARTH'S BEST DEFENSE

"NRDC agrees…that the beneficial use of encapsulated fly ash in products, such as bricks, is sound and is a major source of the reduction of greenhouse gas releases that should be encouraged.

We agree with the [USGBC] that recent gains in appropriate beneficial uses of fly ash bring significant environmental benefits to the building sector and should continue to grow…"

--NRDC letter to CalStar Products, Oct. 21, 2010

"For some types of CCW there are alternative uses as raw material for construction products such as concrete, plaster, and wallboard. When directed toward these 'encapsulated uses,' the dangerous chemicals in the waste are not subject to erosion and leaching into the environment, but unfortunately the majority of CCW is not disposed of in this way."

- *"Dangerous Disposals: Keeping Coal Combustion Waste Out of Our Water Supply" issued as NRDC "Health Facts"*

EARTHJUSTICE

Because the earth needs a good lawyer

"Reuse of ash as a component of asphalt, concrete, and gypsum board are legitimate and safe reuses that should be encouraged. In addition, recycling ash in concrete can result in a large reduction of greenhouse gases …"

Testimony of Lisa Evans, Earthjustice, before the U.S. House Subcommittee on Energy and Mineral Resources, June 10, 2008

Pending Regulation on Fly Ash Disposal

- RCRA: Resource Conservation Recovery Act
  - Subtitle C
    - Hazardous Waste
    - Meets at least 1 of 4 hazardous waste definitions
      - Ignitable
      - Corrosive
      - Reactive
      - Toxic ← only concern for fly ash
    - Subject to *federal* oversight
  - Subtitle D
    - Solid Waste
    - Does not meet hazardous waste definitions
    - Subject to *state* oversight

Fly Ash and RCRA

- 1980: Congress temporarily exempts fly ash from RCRA regulation
- 1981: EPA exempts fly ash from regulation, this time not temporarily
- 1993: EPA concludes regulation under RCRA C is inappropriate
- 2000: EPA again concludes fly ash does not warrant RCRA C regulation
  - Concludes "…beneficial uses of [fly ash], other than for minefilling, pose no significant risk."

EPA Proposals for Fly Ash *Disposal*

- RCRA C, special waste
  - Enforced by **federal** government
  - Subject to hazardous waste disposal requirements
  - Strongly supported by environmental groups
  - Significant concern that stigma of special/hazardous waste will reduce fly ash use
- RCRA D, solid waste
  - Enforced by **state** government
  - Requires use of lined landfills, with proper groundwater monitoring (also required in RCRA C scenario)
  - Supported by concrete users, fly ash users, industry, CalStar
- Beneficial reuse remains exempt from regulation in both options

Beneficial Reuse Recommendations

- Fly ash recycled into a variety of materials
  - Concrete: used as 1-to-1 replacement for portland cement, regularly up to 30% of cement (can easily go as high as 50%)
    - For every ton of FA used instead of cement, ~1 ton of CO_2 is avoided
    - ~14M tons of FA used in concrete in 2007:
    - prevents ~14M tons CO_2 from being released
    - If we continue at current rate, can avoid >170 M CO_2 tons in next 10 years
  - Raw feed for clinker (proto-cement)
  - New construction materials such as CalStar products

CalStar and Fly Ash

- Materials and process
  - Fly ash and aggregates
  - Low temperature, high humidity curing
- Environmental impact
  - 50-85% reduction in energy and 85% reduction in CO_2 compared with traditional fired clay or concrete bricks and pavers
  - Diverts fly ash from landfills
- Environmental safety
  - Leaching: no concern, based on results of TCLP (simulates municipal solid waste landfill) and SPLP (simulates rainfall) tests
  - Handling: no concern, based on dermal contact wipe tests

In More Depth: Fly Ash Constituents

- Fly ash composed primarily of SiO_2, Al_2O_3, CaO, Fe_2O_3 equivalents
  - Fly ash, cement, and clay are all made of the same general compounds, just in different amounts
- Also has minor oxides, and trace oxides
- Some heavy metals among trace oxides
  - Trace oxides are just that: trace
  - Testing can determine whether or not they will leach at any levels of concern for hazardous materials
    - Most fly ashes do not pose any concern

Fly Ash Types

- Two basic types of fly ash
  - F
    - From bituminous and anthracite coal
    - More than 70% is $SiO_2 + Fe_2O_3 + Al_2O_3$
    - Currently, about 65% of fly ash produced in US
  - C
    - From lignite and sub-bituminous coals
    - More than 50% is $SiO_2 + Fe_2O_3 + Al_2O_3$
    - C typically has higher CaO, often up to 10%, can be as high as 25%
    - Self-cementing
    - Currently, about 35% of fly ash produced in US

For more information, or speak to a CalStar material scientist, please email:

info@calstarproducts.com