Reclaiming and Recycling Coal Ash for Beneficial Use

Environmental Show of the South, Chattanooga, Tn

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May 16, 2019
TRANSFORMATIVE SOLUTIONS
Removing Coal Ash From The Environment
Source/Operating Locations

Thermally Beneficiated over 7 million tons of fly ash in the last 20 years
BENEFICIAL USE OF FLY ASH IN CONCRETE

Projects using fly ash in high-performance concrete
Beneficial Use of Fly Ash
Concrete Applications

Roman Concrete used large amounts of volcanic ash in their structures.

It has been used extensively in the US since 1942 when fly ash was used in the Hoover Dam Spillway Repair Project.
Why use Coal Ash?

✓ Lower Cost than Cement

✓ Greater Ultimate Strength

✓ Improved Durability / Longer Life
Every ton of coal fly ash used in concrete reduces carbon emissions by one ton

Proven Environmental Benefits
### CHEMICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Type F</th>
<th>Type C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO$_2$ + Al$_2$O$_3$ + Fe$_2$O$_3$, Min. %</td>
<td>70.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Sulfur Trioxide (SO$_3$), Max %</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Moisture Content, Max %</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Loss On Ignition, Max %</td>
<td>3.0-6.0*</td>
<td>6.0</td>
</tr>
<tr>
<td>Available Alkalis, Max %</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>CaO (typically)</td>
<td>&lt;10%</td>
<td>&gt;20%</td>
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</tbody>
</table>

*DOTs < 3%, AASHTO < 5%, ASTM < 6%*
Fly Ash Management

Historical

- Wet Disposal
  - Non-spec
  - Dry Disposal
    - Spec
    - SEFA
- Commercial Applications
Fly Ash Management

Reduced Commercial Use
due to Environmental Controls

Dry Disposal

Non Spec

Non Spec

SEFA

Spec

Commercial Applications

Non Spec

Non Spec

SEFA
BENEFICIATION TECHNOLOGIES

Turning Industrial Wastes into Valuable Products
Fly Ash Management
Beneficiation Required to Improve Fly Ash Quality

Dry Disposal
Reduced or Eliminated

Non Spec
Fly Ash Beneficiation
Spec

SEFA
Commercial Applications
Coal Ash Beneficiation

Beneficial Use of Coal Ash

Common Beneficiation Processes

- Chemical Treatment (CT)
- Electrostatic Separation (ST)
- Thermal Beneficiation
Coal Ash Beneficiation
Commercial Processes

Chemical Treatment
- Inoculates Unburned Carbon
- Dosage rate varies by LOI and Carbon Type
- Limited LOI range (<6%)

Product Fly Ash
- Improved Air-Entraining Characteristics
- No reduction in LOI
- No change in Fineness and Strength
Coal Ash Beneficiation

Commercial Processes

**Electrostatic Separation**
- Separates Unburned Carbon
- Two Product Streams:
  - Low Carbon Fraction
  - High Carbon Fraction (Waste)

**Product Fly Ash**
- Improved Air-Entraining Characteristics
- Reduction in LOI
- Improved Fineness and Strength
Coal Ash Beneficiation
Commercial Processes

**Thermal Beneficiation**
- Oxidizes Unburned Carbon
- Self-Sustaining
- Exothermic Process
- No Solid Waste Stream

**Product Fly Ash**
- Transparent Air-Entraining Characteristics
- Increased Fineness
- Superior Strength (STAR)
STAR® Technology
Beneficial Use of Fly Ash
McMeekin
STAR®, SC

Capacity - 35 mmBtu/hr
e.g. 12 tph @ 10% LOI

Scope:
SEFA - Owner, Operations,
Marketing

Timeline:
Commercial Operations began in
February 2008

Feed Sources:
Sixteen (16) different ash sources
(5.0% to 25.0% LOI)

Product Quality:
Shipments have averaged 1.0% LOI

WWW.SEFAGROUP.COM
Morgantown
STAR® II, MD

Capacity - 120 mmbtu/hr
e.g. 40 tph @ 10% LOI

Scope:
GenOn Owner. SEFA Operations and Marketing

Timeline:
Commercial in Sept. 2012

Feed Sources:
Three (3) different ash sources ranging from 5.0% to 15.0% LOI

Product Quality:
Shipments have averaged below <1.0% LOI
STAR Process Advantages

- Self-Sustaining
-Eliminates Unburned Carbon
-Exothermic Process
-No Solid Waste Stream
-Lower NOx & CO Emissions
-Wider Range of Feed Material Characteristics
-Eliminates Ammonia on Ash
-Higher Quality End Product
  a) Enhanced strength reactivity index
  b) Better ash chemistry due to lower carbon and organics
  c) Pure Mineral Matter
  d) Diversified Market Opportunities
FUTURE AVAILABILITY OF COAL ASH

Impact on Fly Ash Supply
Future Availability of Coal Ash
Impact on Fly Ash Supply

U.S. net electricity generation from select fuels (billion kilowatthours)

- Coal
- Natural gas
- Nuclear
- Renewable energy
- Petroleum

Reference case

2016

History | Projections

Fly Ash Management

Reduced Coal Fired Generation
Reduced Fly Ash Supply

Dry Disposal
Reduced or Eliminated

Non Spec
SEFA

Spec

Commercial Applications

STAR

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RECYCLING COAL ASH FROM LEGACY SITES

Turning Industrial Wastes into Valuable Products
Future Availability of Coal Ash
Impact on Fly Ash Supply
Reclaim Ash Testing

• Tested Wateree Pond Ash at McMeekin STAR
• Ash - 25% Moisture, 10% LOI
• Maintained stable operating conditions within STAR design range
• Maintained typical STAR high quality product <1% LOI
• Product no different from Dry Feed ash product in concrete
• No increase in emissions - lower SO2
STAR® Technology
Beneficial Use of Reclaimed Fly Ash
Winyah STAR
Reclaim
Georgetown, SC

Capacity - 130 mmbtu/hr
e.g. 45 tph @ 10% LOI

Scope:
SEFA Owner, Operations, and Marketing

Timeline:
Broke Ground Jan. 2014
Commercial in April 2015

Feed Sources:
Winyah Plant and/or Winyah Ponds (6.0% to 15.0% LOI)

Product Quality:
Shipments have averaged below 0.5% LOI
Winyah Reclaim STAR Plant

- Winyah STAR makes constant adjustments based on ash sources and characteristics.

- Feed material is most often 100% reclaimed ash from onsite impoundments. Over 850,000 tons of reclaimed ash processed.

- STAR is capable of and often switches with only moments of notice to 100% dry fly ash when the Winyah Generating Units come online.

- To date over 800,000 tons of Winyah STAR ash used in production of concrete. Of this 600,000 tons from Reclaim.
THANK YOU! QUESTIONS?

www.sefagroup.com