Coal Combustion By-Products

Waste to Wealth

Green Product Substituting Cement

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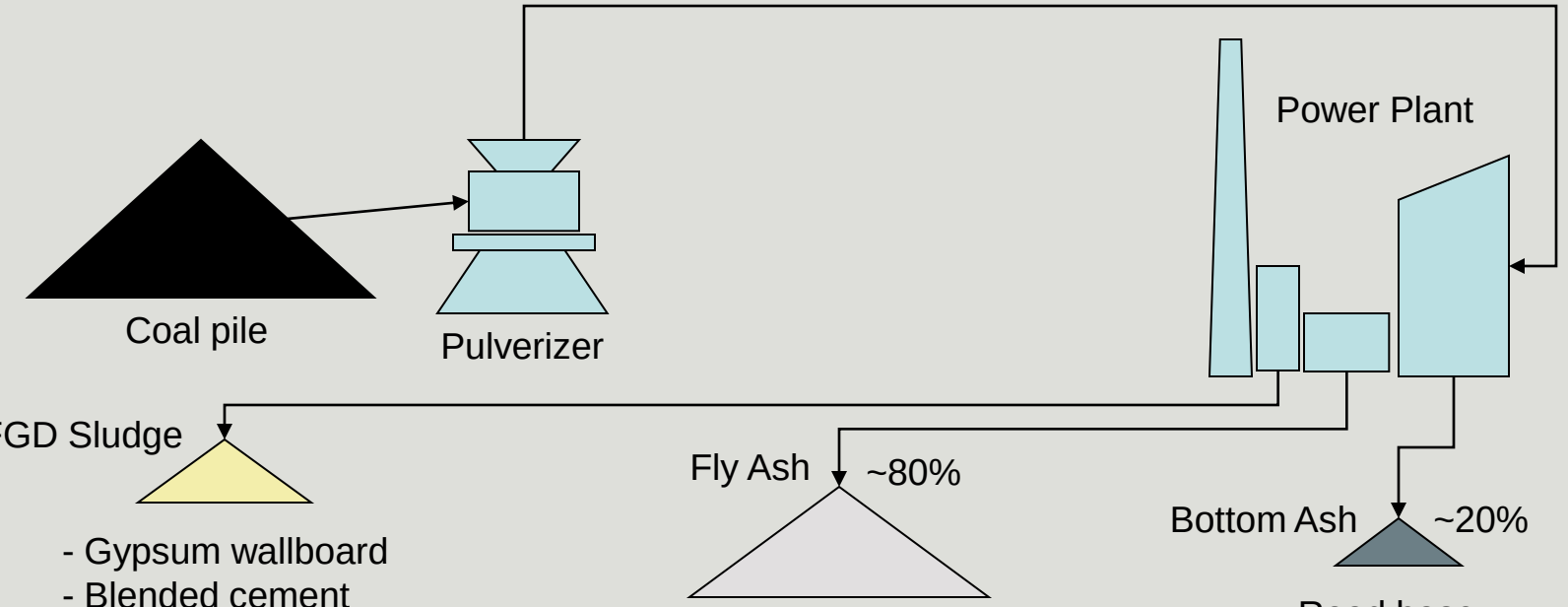
Thanks to Mission Energy

Coal Combustion By-Products (CCB) examples



CCB Utilization

- Around 200 million tons fly ash produced Annually
- 60% Fly Ash is Consumed in construction & Cement
- Average Ash Percentage in Coal is around 35%
- Dependent on local markets, hauling costs, economy
- CCB stigma if regulated as hazardous waste
- Local Product considering high Logistic cost.
- Beyond just utilization – must consider ash material Reduction, Conversion and Reclamation options
- Major disposal issue in Bihar, Chhatishgarh, Orissa, UP, MP, Telangana, Karnataka and Vidarbha region of Maharastra.
- Costal Regions using cheap water transport option.

FlyAsh Utilization Details

- Cement Replacement : 25%
- Mines Filing : 10%
- Low Lying Area Reclamation : 10%
- Bricks and Tiles : 10%
- Roads and Fly Overs : 5%
- Unused Flyash (Pond Ash /Ash Dykes) : 40%

Unused Fly ash Disposal cost and future Liabilities to Power Utility is estimated to around Rs 300/- PMT.

Disposal Cost is Rs 25-50 Crore Per Anuum for a 1000MW Power Generation Utility, in wet ash infrastructure O&M and future disposal liability.

Fly Ash Properties

- **Fineness.** The fineness of fly ash is important because it affects the rate of pozzolanic activity and the workability of the concrete.
- **Specific gravity.** Although specific gravity does not directly affect concrete quality, it has value in identifying changes in other fly ash characteristics.
- **Chemical composition.** The aluminosilicate components react with calcium hydroxide to produce additional cementitious materials. Fly ashes tend to contribute to concrete strength at a faster rate when these components are present in finer fractions of the fly ash.
- Sulfur trioxide content is limited to five percent, as greater amounts have been shown to increase mortar bar expansion.
- Available alkalis in most ashes are less than the specification limit of 1.5 percent. Contents greater than this may contribute to alkali-aggregate expansion problems.
- **Carbon content.** : Limited to 5% to avoid air entrapment.

Fly Ash in Portland Cement Concrete

- **Improved workability.** The spherical shaped particles of fly ash act as miniature ball bearings within the concrete mix, thus providing a lubricant effect and smooth placement.
- **Decreased water demand.** The replacement of cement by fly ash reduces the water demand for a given slump. When fly ash is used at about 20%, water demand is reduced by approximately 10%
- **Reduced heat of hydration.** Replacing cement with the same amount of fly ash can reduce the heat of hydration of concrete.
- **Increased ultimate strength.** The additional binder produced by the fly ash reaction with available lime allows fly ash concrete to continue to gain strength over time & exceeding straight cement.
- **Reduced permeability.** The decrease in water content combined with the production of additional cementitious compounds reduces the pore interconnectivity of concrete, thus decreasing permeability.

Fly Ash Creates JUNG RODHAK Ability

- **Improved durability.** The decrease in free lime and the resulting increase in cementitious compounds, combined with the reduction in permeability enhance concrete durability.
- Improved resistance to ASR. Fly ash reacts with available alkali in the concrete, which makes them less available to react with certain silica minerals contained in the aggregates.
- The **alkali–silica reaction** (**ASR**), more commonly known as "concrete cancer", is a swelling reaction that occurs over time in concrete between the highly alkaline cement paste and the reactive non-crystalline (amorphous) silica found in many common aggregates, given sufficient moisture.

JUNG RODHAK Cement

- Fly ash induces three phenomena that improve sulfate resistance:
  - Fly ash consumes the free lime making it unavailable to react with sulfate
  - The reduced permeability prevents sulfate penetration into the concrete
  - Replacement of cement reduces the amount of reactive aluminates available
- Improved resistance to corrosion. The reduction in permeability increases the resistance to water ingress & resultant corrosion.

Alkaline Activation of FlyAsh

It’s a process in which flyash is mixed with Alkali Activator to produce paste capable of setting and hardening in short time

- For Manufacturing OPC-free Railway Sleeper
- For making fire proof and corrosion proof coatings
- For Water Proofing Applications
- For manufacturing light weight materials & Matrices in place of Sand-witch panels.
- Highly concentrated Alkali Hydroxide or silicate used as activator.
- Strength values over 40MPa after short thermal curing
- Ready mix plasters, infra Green Cement and Skim Coats

Role of Additives in Optimization of Flyash

- The study showed that with the use of various additives like naphthalene–based superplasticizer, calcium nitrite, calcium formate or blend of these additives, It is possible to increase the flyash content up to 50% in OPC.
- The addition of flyash has no negative effect on the compressive strength of cement up to 50%. Strength can be controlled with blain of flyash above 400, utilizing classification and grading techniques.
- The study will help to utilize more flyash in OPC, thereby helping to save limestone used in the manufacture of clinker and hence environmental pollution caused due to CO2in the clinker production.
- The 35% limit is the upper limit fixed by Indian standard.
- The addition of superplasticizer in cement disperses the cement particles and allows the glassy content of the fly ash to react effectively with the lime liberated by the hydration of the cement to form CSH.

FlyAsh Challanges

- Not all Flyash can be used as Cement Replacement, only 25-35% fine ash is usable in RAW form as Cement Replacement.
- Fly ash Disposal cost in wet form and future Liabilities to Power Utility is estimated at around Rs 200-300/- PMT.
- Flyash disposal as Pond Ash shall cost Rs 50 Crores per Anuum to a 1000MW Power Generation Utility.
- Hence there is potential of Improving Bottom Line by Rs 50 Crore Per Anuum by ensuring 100% Dry disposal of Coal Combustion Products.
- Companies like Ashtech can Partner with Power Utilities to formulate and implement action plan for 100% dry disposal.
- Most Power Utilities are dependent on Cement Plant to buy Fly Ash, which are Targeting only 25% fine Ash Generated in 3rd to 7th ESP fields, & loosing in Cost of Disposing 75% Ash Generted in Bottom Ash, ESP 1st & 2nd Field etc.

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Processor, Distributor, Manufacturer, Importer and Exporter

"We Understand Coal Ash Better"

Ashtech Formulations

- Flyash Classification, Grading & Grinding techniques
- Generation of Silica Fume Substitution Products
- Flyash Activation to improve Lime Reactivity
- Activated Flyash Supply to Cement & Concrete Companies
- Flyash Soil Stabilizing Techniques.
- Flyash Polymer Concrete for Roads and Dams - Hoover Dam in Las Vegas is constructed in Record time, using Flyash Concrete.
- Flyash Coatings for Corrosion and Erosion Prevention.
- Flyash based Low Lying Area Reclamation and Stablization.
- Flyash Based Soil Benefication Products to Improve Land Fertility.
- Cost Effective Logistic Solutions.
- Admixtures to Improve Flyash Utilization in Concrete upto 50%.
- Flyash Sand and Ready Mix Plasters.

Educating Power Utilities

- Want to sell Raw Fly ash Directly to consumers
- End up in max dry sales of 25% fine Fly Ash.
- 25% Fly ash Becomes Revenue Stream.
- Forget about 75% Ash eating away money, in wet disposal and creating future liability to company, country and environment.
- Whatever is saved in 25% sale is gone in 75% Wet Disposal, in addition to future liability besides risk of business closure.
- Fly ash is specialized Business Area.
- Power Utilities must partner with Ash management Companies.
- Power Utilities should focus of 100% Dry Disposal in place of sales of fine flyash products.
- 100% dry disposal would automatically save them more money in comparison to selling 25% and disposing 75% in Wet Form

Ash Management

- Market research to develop & promote beneficial usage of CCP.
- Local coordination, training, guidance, support to improve awareness about use of flyash in Agriculture, Bricks, Concrete, construction, land fills etc.
- Ash Quality Monitoring and Reporting.
- Processing, Sale and Disposal of All kind of Coal Combustion Products.
- Preparing Project Report for Commercial use of Fly Ash and Ash Products & its implementation.
- Proving Logistics Support for Environment Friendly Dry Ash Handling and Disposal.
- Identification, Treatment and Management of Land fills
- Ash Pond Management and Pond Ash Processing & Utilization.
- Identification of Technologies for Ash Processing
- Pilot Experiments to create new avenues of Ash Use
- Creating awareness : Flyash is better than cement for construction purpose as it helps in eliminating corrosion, porosity and Cracks in construction apart, from providing long term strength.

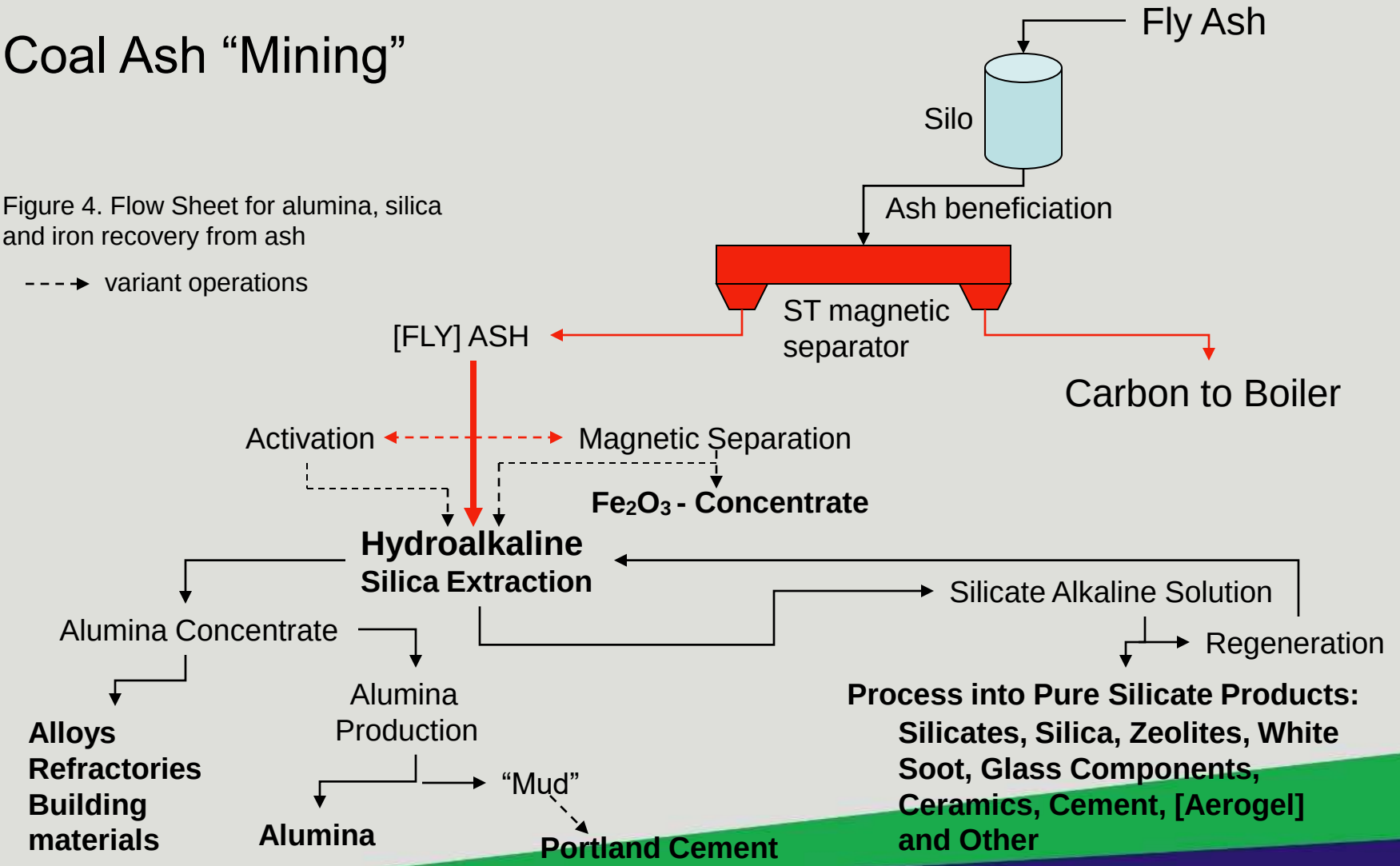
Other Beneficiation & Mining Techniques

Coal Ash Conversion Option Using Russian Hydroalkaline process with ST magnetic separator

Coal Ash "Mining"

Figure 4. Flow Sheet for alumina, silica and iron recovery from ash

---→ variant operations



Coal Ash “Mining”

Coal Fly Ash Processing into Metallurgical and Silicate Chemical Products:

- Russian HYDROALKALINE pilot process with magnetic recovery of concentrated Fe_2O_3
- Ferric-oxide recovery approx 50%
- Hydroalkaline silica extraction approx 60%-77%
- Bauxite quality Alumina ash remaining for processing
- Alumina production residue “mud” is considered a valuable Portland cement additive

Ash Beneficiation Alternatives: (see Coal Processing)

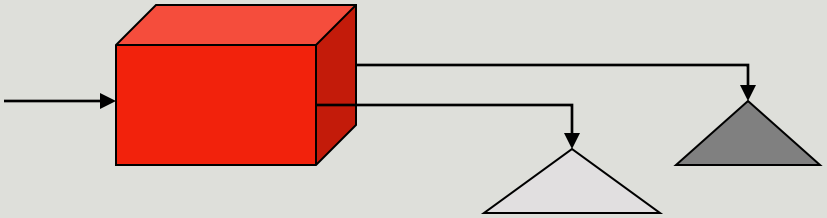
- Separation Technologies (ST) process separates carbon from fly ash w/ carbon recycled back to boiler
- PMI Ash Technologies carbon burn-out technology with heat recovery back to boiler

RockTron Eco-Minerals

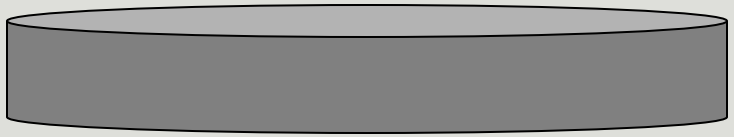
- RockTron is a UK company; http://rktron.com
- Fiddler's Ferry eco-mineral processing plant is on-line
- Designed to process 800,000 tons of fly ash per year
- Processes both fresh and stockpiled ash (ash pond?)
- RockTron eco-mineral coal-ash products:
  - Alpha and delta cement additive pozzolanic glass spheres
  - 90% purity carbon
  - Cenospheres
  - Spherical magnetite

RockTron Eco=Mineral Reclamation Process

- RockTron eco-mineral recycling of ash ponds(?)

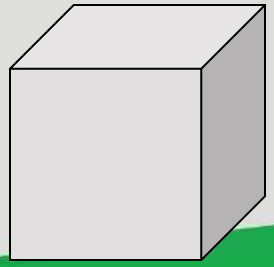


- Replacement with lined ash ponds and enhanced dams



- Dewatering bags within lined basins

- Convert de-watered pond ash into Geopolymer Concrete for enhanced structures and/or products



Keystone Metals Recovery, Inc
Process for recovering Metals from Coal Ash

- The coal ash is heated in a CFBC using coal and the carbon in the ash (LOI) to break the physical bonds of the metals in the ash with the waste heat used for a small T/G or used to by-pass feedwater heaters in the plant.
- The ash is chlorinated with the metal chloride gases (Al, Ti, Fe, and others) removed from the remaining solids (Silicon oxide) in cyclone separators. Coal ash has the following:
  - 50% to 55% sand
  - 22% to 35% Al
  - 3% to 10% Fe
  - 1% to 1.5% Ti
  - Trace quantities of germanium, gallium, Hg, etc.
- The metal chlorides are reduced to molten metals and formed into ingots for sale. (electricity used to produce the Al from the chloride is 65% less than production from bauxite). Ball
- The remaining sand can be stacked on site or sold.

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