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WPCA-FirstEnergy ELG Seminar

PASTE TECHNOLOGY AND ELG

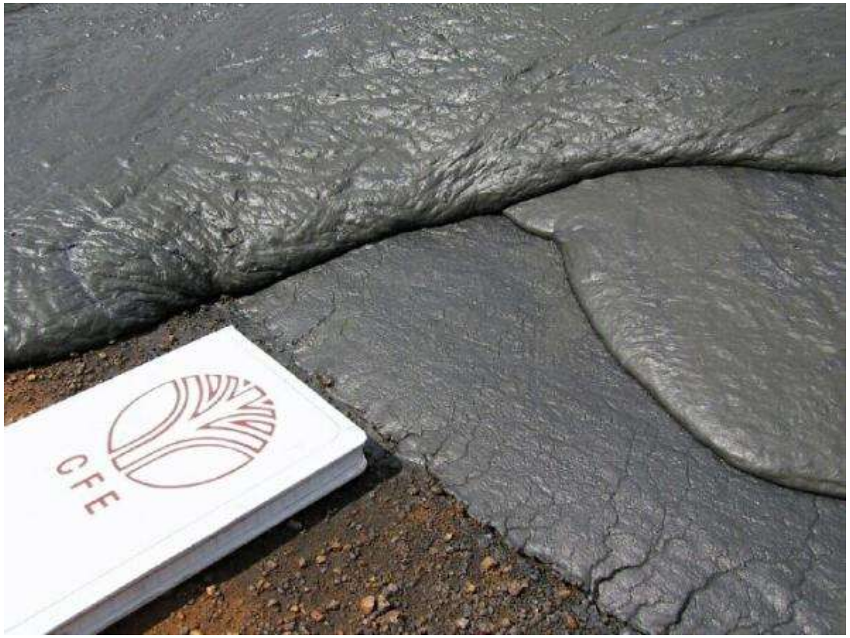
February 19, 2020

HSSE share

Sitting is the

NEW smoking

AGENDA



- Fixation
- Evolution of Paste
  - Mining Industry
  - Power Industry
- Recipe development
- FAQ’s
- Summary

Why are we Fixated on Fixation?

Solidification

Sequestration

Encapsulation

Stabilization

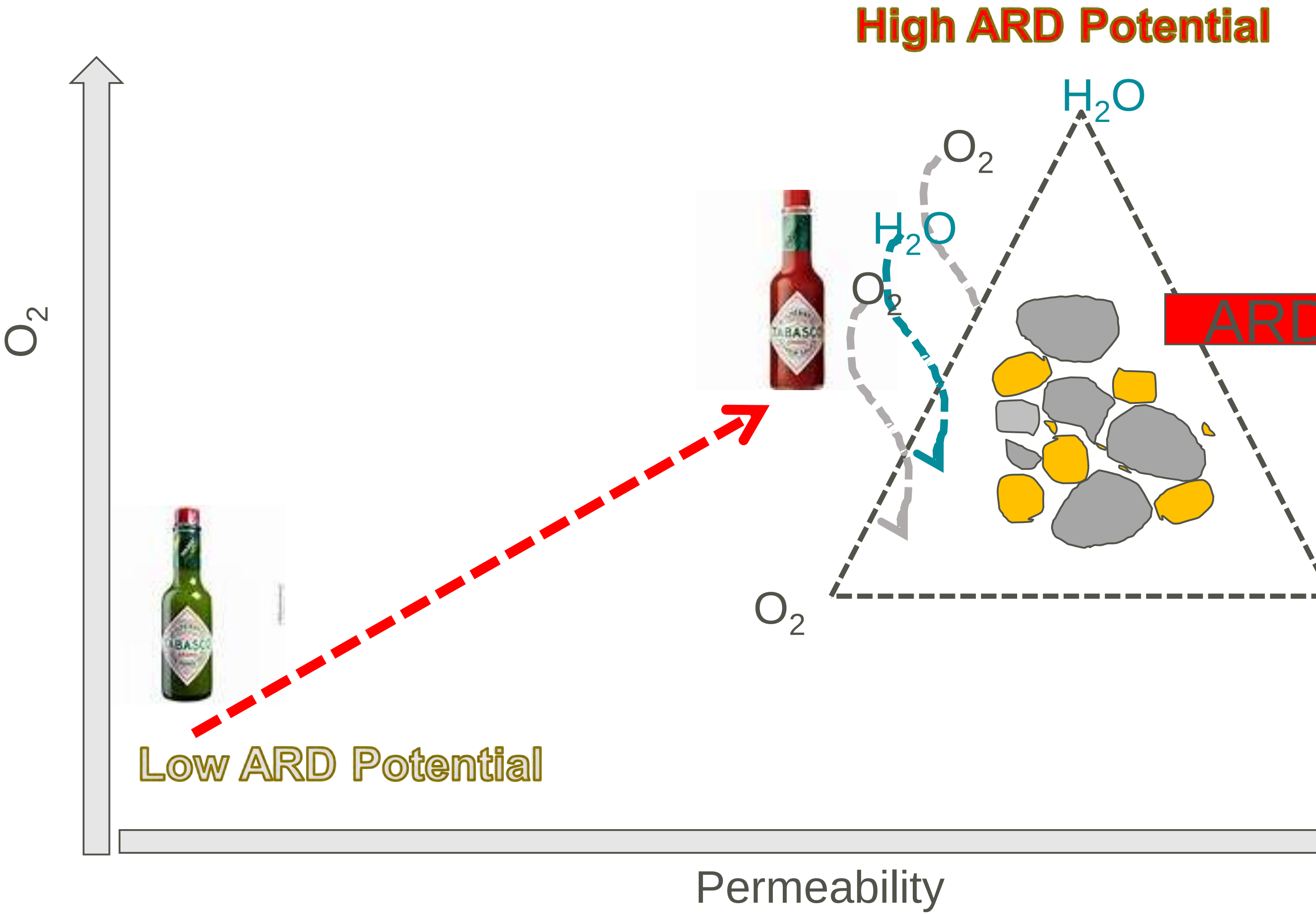
All of these terms have been used to describe the desired end state for both CCR materials and wastewater treatment residuals/streams.

What do they all mean?

- Technical definition is the action of making something firm or stable
- Ultimately looking for long term immobility (geotechnically and geochemically)

The Importance of Yield Stress for Geotechnical Immobility

The Importance of Permeability for Geochemical Performance



Evolution of Paste

Evolution of Paste – Underground Mining

- Introduced to the mining industry over 30 years ago
- Underground backfill for active mines
  - Reduces operating cost over traditional methods
  - Offers greater flexibility to the mine sequencing plan
  - Increases ore recovery and improves mine safety and long term geotechnical stability
  - Minimizes contamination loading on underground mine water systems
- Underground backfill for legacy mines
  - Eliminates geohazards
  - Minimizes ARD and other environmental impacts

Evolution of Paste – Surface Mining

- Advantages over traditional methods included:
  - Reduces overall mine water consumption
  - Diminishes or eliminates seepage, water bleed, metal leaching and acid generation
  - Reduces the size of the tailings containment structures

  - Maximizes the mine's waste storage capacity
  - Reduces or eliminates the amount of ponded water
  - Makes reclamation and closure possible sooner/faster

Evolution of Paste - Power

- Since the early 2000's South African, Brazilian and US power plants have chosen to investigate and/or implement the use of paste.
- Recent changes in legislation for CCR and ELG have motivated the industry to further explore paste technology. It has multiple applications
  - Closure
    - Material handling and cost optimization
  - FGD / Brine encapsulation
    - Fly ash as a sink for FGD / Brine
  - Mine backfill
    - Beneficial reuse for abandoned/historic geohazards

Paste Recipe Development

CCR + Brine Paste Test Work

Two test programs:

- One US based
- One South African based

Both looked at combining fly ash with FGD (solids + water)

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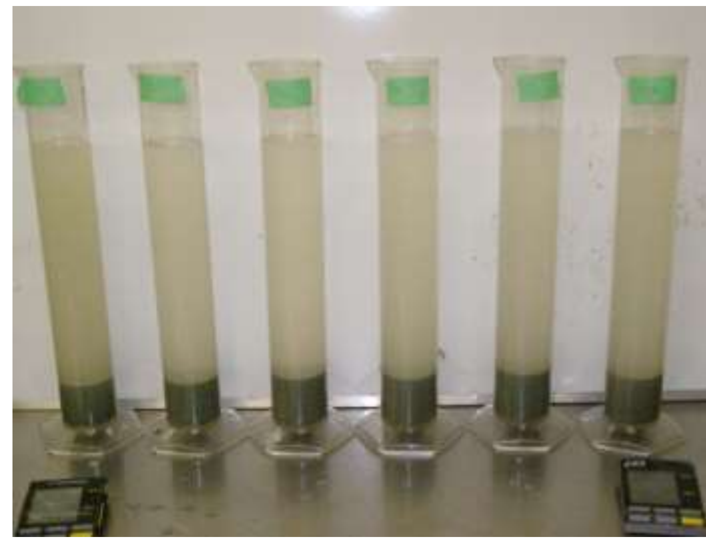
CCR Test Work – US example

Fly ash, bottom ash and FGD solids (gypsum) samples from a southern US plant were tested for:

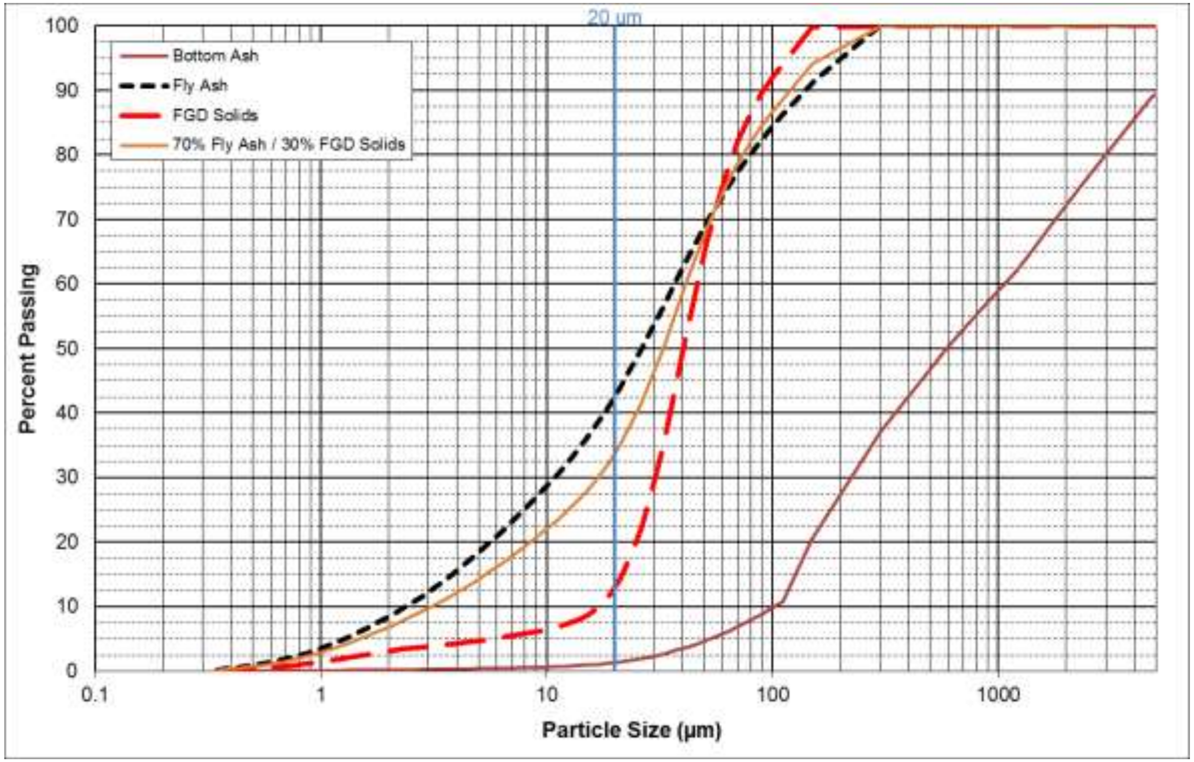
- Blend interaction
- Dewatering properties
- Rheology
- Acid generation and
- Metal leaching potential



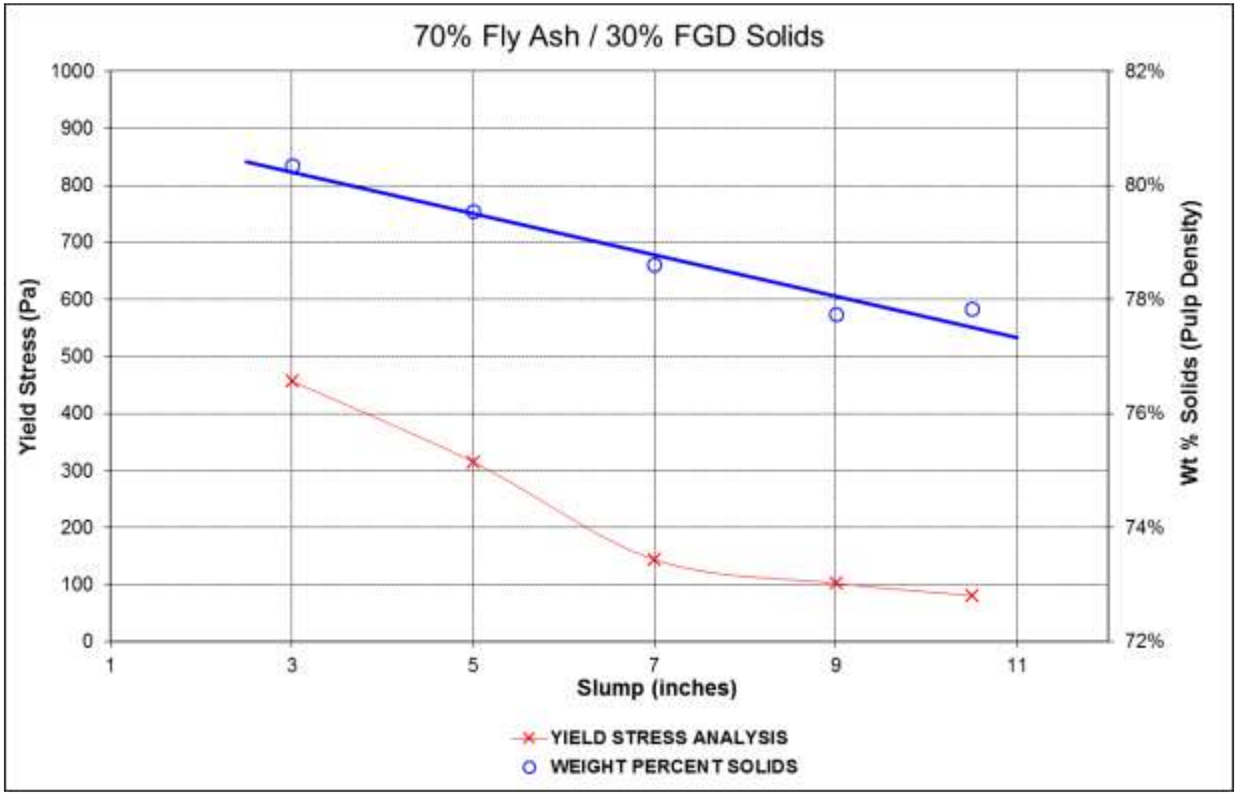
Testing was performed on a blend of 70% FA and 30% FGD Solids

Particle Size Distribution

- Paste requires ~15% fines (<20 µm)
- 70% FA and 30% FGD Solids met this requirement



Rheology



Typically paste material for surface disposal has a slump value of 10” or less

Rheology

No slump

10”slump

7”slump

Due to its lower solids content, a 10” slump paste will have a lower yield stress and flow further distances than a 7” slump paste

Paint Filter

The paint filter test shows an indication of the capability of the CCR paste to encapsulate water and any other harmful contaminants.

Slump	Sample Densities (wt% solids)	Free Liquids Present?	Amount of Free Liquid (ml)	Filtrate Discharge Quality
3"	80.4%	no	0	N/A
5"	79.6%	no	0	N/A
7"	78.6%	no	0	N/A
10.5"	77.8%	yes	1	dark

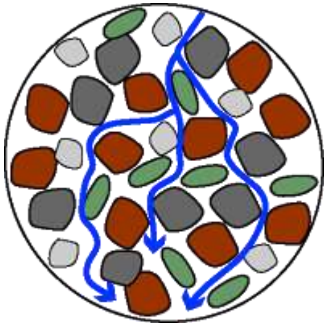
- Only the 10.5" slump did not pass, the rest did

Acid Generation and Leaching

- Theoretical hydraulic conductivity of the 70/30% sample is 9.63 x 10^{-6} cm/s

The multiple approaches to assess acid generation potential revealed that the samples were largely not potentially acid generating

Constituents such as cadmium, copper, nickel, uranium and zinc were retained in the mix



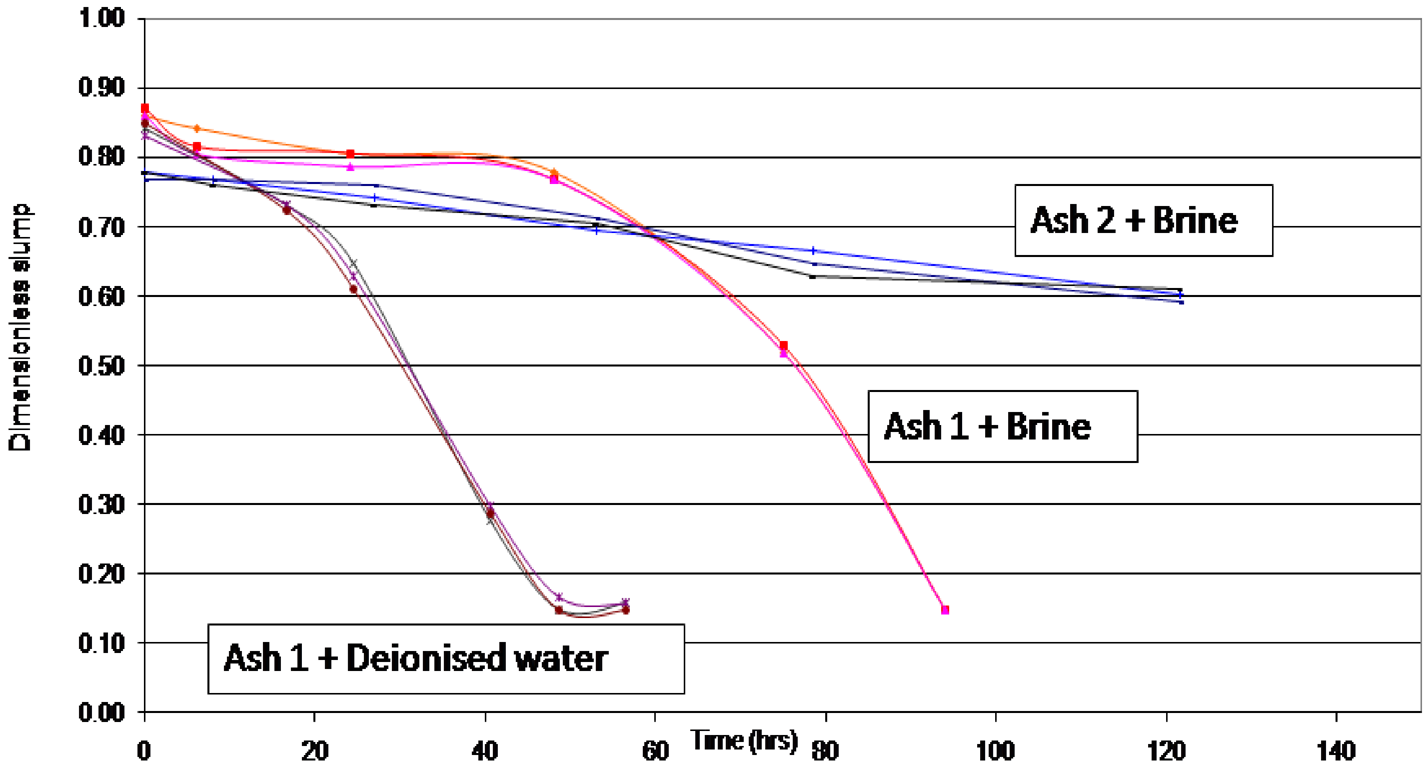
The paste mix neutralized the FGD water

CCR Test Work – South Africa example

Testing program performed in South Africa in the late 2000’s

The program assessed the performance of fly ash and wastewater brine paste vs. fly ash and deionized water

Fly ash + Brine Paste Performance



Slower hydration times allows for longer pumping distances

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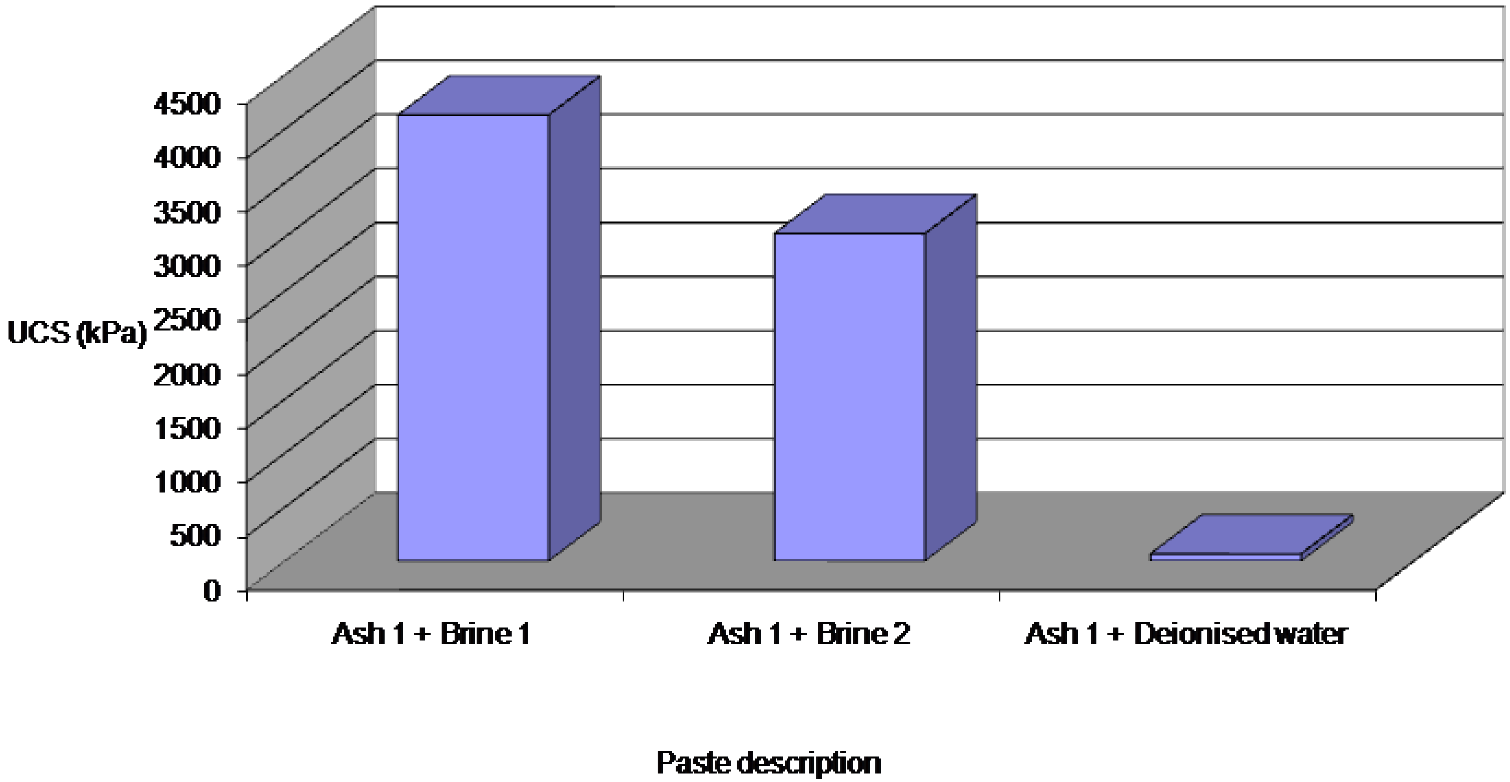
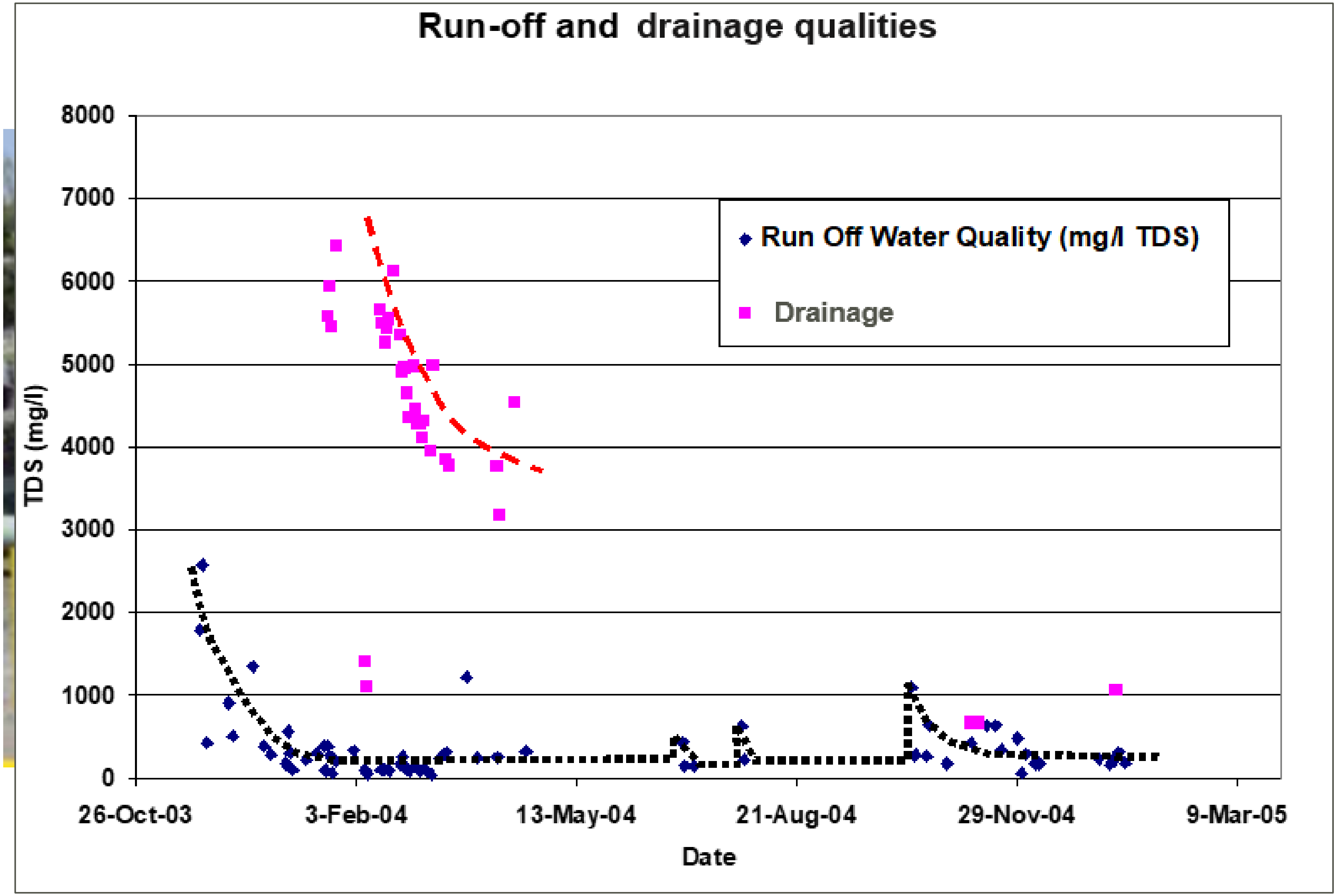
Fly ash + Brine Paste Performance



Paste prepared with brine also obtained higher unconfined compressive strength values



Run-off and drainage qualities
8000
7000
6000
5000
4000
3000
2000
1000
0
TDS (mg/l)
Run Off Water Quality (mg/l TDS)
Drainage
26-Oct-03
3-Feb-04
13-May-04
21-Aug-04
29-Nov-04
9-Mar-05
Date

Recipe Summary

Bad news

- Every site / material is unique so you must undertake a testing program to confirm recipe and associated behaviour and performance
- Material balances will drive the recipe to some extent
- Using fly ash as part of the recipe will potentially divert it from resale streams

Good news

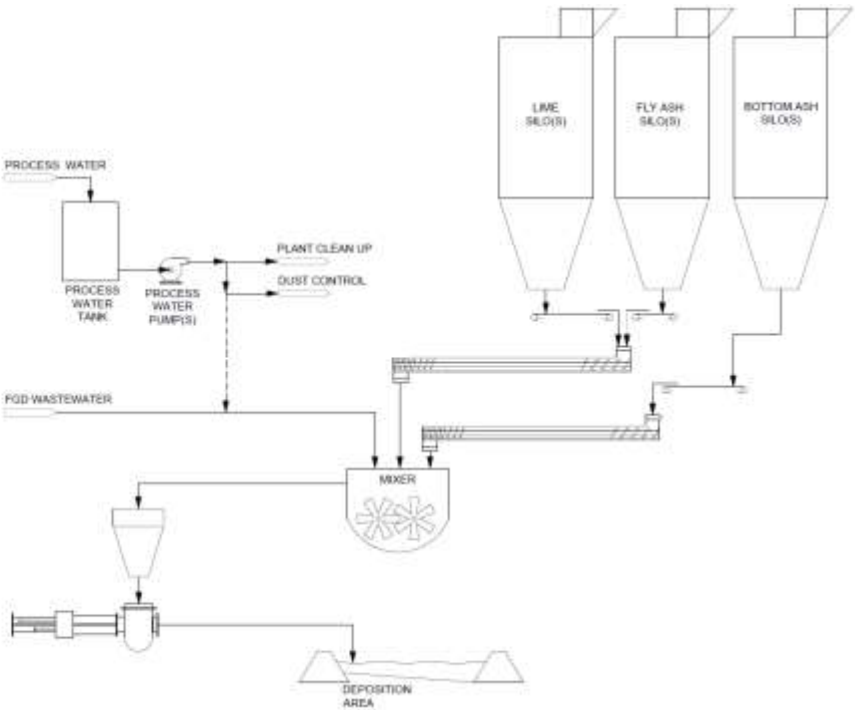
- Lots of different fly ash and bottom ash materials have been tested from around the world
  - South Africa / Brazil / USA Canada
- And they all make pretty good pastes so paste works in general and fly ash works in particular
- There are full scale fly ash paste plants in operation and approximately 50+ full scale mining paste plants in operation
- Is a viable, economically feasible process to deal with the brine output of water treatment and potentially the full FGD stream prior to water treatment

Flowsheets

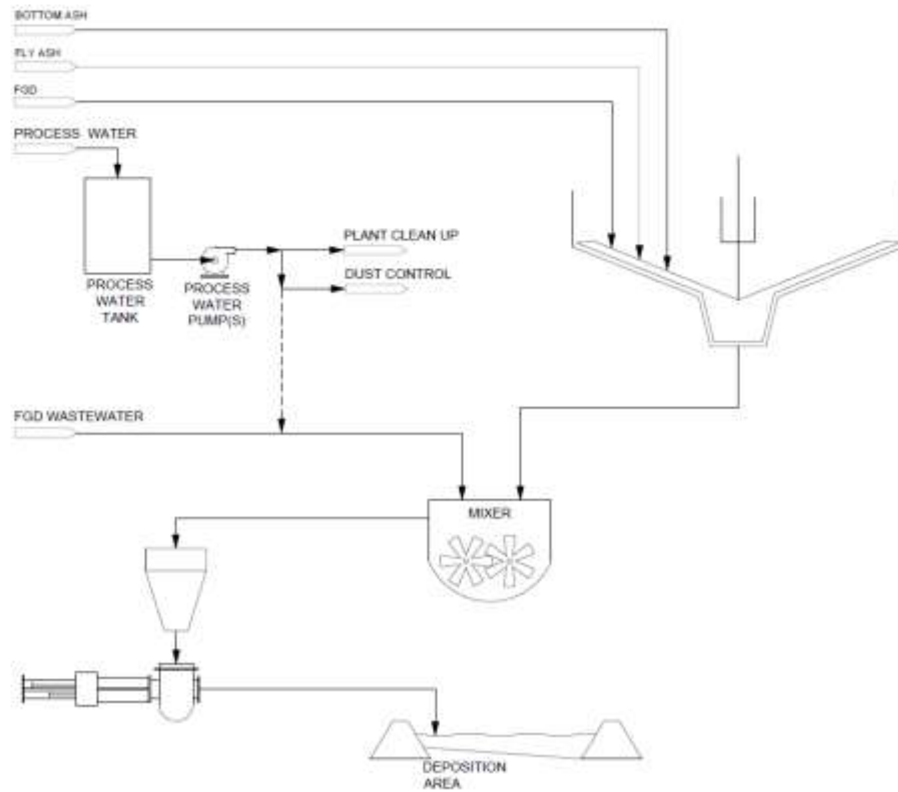
& Equipment

Fly ash + Bottom ash + Water (FGD)

Dry Feed Materials



Wet Feed Materials



Yield Stress versus Deposit Slopes

Slurry Placement

0 – 1%

High Density Slurry Placement

1 – 2%

High Slump Paste Placement

2 – 5%

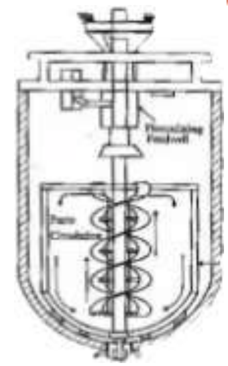
Low Slump Paste Placement

3 – 10%

Dewatering Equipment

DEWATERING EQUIPMENT	% SOLIDS BY WEIGHT
NONE	10-30
THICKENER	50-60
DEEP TANK	65-75
THICKENER & FILTER	75-85
CENTRIFUGE	80-90

EQUIPMENT



Mixing Technology

Mobile Systems

Permanent Systems

Dewatering versus Pumping

Slurry Placement →

→

Centrifugal Pump (lower pipeline pressures)

High Density Slurry Placement →

→

Centrifugal or Piston/Diaphragm Pump (high pipeline pressures)

High Slump Paste Placement →

→

Piston/Diaphragm Pump (higher pipeline pressures)

Low Slump Paste Placement →

→

Dual Piston Positive Displacement Pump (high pressure pipelines)

FAQ’s

Common Paste questions

Is there is a regulation requirement governing how to disposal of paste?

There is no specific regulation governing the disposal of paste. It obviously depends state to state but as water is not being used as the medium of transport in the pipeline (it is the fines in the matrix) and assuming the paste passes the paint filter test (which most do) then in theory there should be no issue with depositing paste in a landfill that was permitted for “dry” ash.

How do you make paste?

We make the paste from “dry” fly ash and wet FGD solids and/or water and possibly lime to help activate the reaction though it is not always needed. Dry fly ash can be created by dewatering wet material from a pond or coming off the existing process. Once the paste gets transported and deposited in a landfill there is no further treatment required other than capping and closing the facility when operations are complete.

More Common questions

How far can you pump it?

- 1-2 miles in single stage pumping – almost as far as you like with boosters. Current project has an 11 mile distribution system with single stage pumping. Depends on rheology.

Is plugging the pipeline with paste a concern?

- Not really – paste is effectively a weak concrete and how often have you heard about concrete lines plugging when they build multistory buildings. It is about the correct pump and the correct operating procedures.

How do you clean out paste pipelines during stoppages?

- Pipeline cleanup processes have become more efficient

combining water flushing, compressed air and pipeline pigging.

What if your paste is too thick or sets up too fast to pump?

- Admixtures/reagents are available to modify the behavior of the paste during transport and deposition to slow down the reactions.

Does paste have to pass paint filter at the point of deposition i.e. at the end of the discharge pipeline?

- Not necessarily – the paste process is only partially done at the point of deposition. Once the material is in the deposition facility the hydration of the paste is continuing to happen which increases strength, lowers permeability and in some cases the water that bled off at deposition gets sucked back into the matrix during the hydration process.

A few more questions

What is the method considered for transport of the paste to the landfill? Trucking or pipeline? If pipeline, what equipment is envisioned and what prevents the pipeline from plugging since the paste is continuously hardening?

The typical method would be pipeline transport to the landfill. The typical pumping arrangement would be a positive displacement (PD) pump and a 6-8 inch pipeline (depends on volume throughput required). The pump selection is usually dependent on pumping distance and rheology so this should be verified that PD pumps are required.

In terms of the plugging question, it is true that the paste is hardening however the reaction does takes some time to begin (much like concrete). The start of the reaction could take 1 hr, 4 hrs or longer – it depends on the material. So you would have test to understand the window of operation.

What type of flyash can be used?

We have used both Type C PRB and Type F ILB in different trials.

Paste Summary – CCR and ELG

- Co-disposal opportunities
  - Fly ash
  - Bottom ash
  - FGD wastewater
- FGD wastewater becomes part of the feed material to the recipe
- Metals / contaminants of concern are encapsulated in the paste matrix
- Seepage / leachate / bleed are minimized
- Potential to put back u/g, in pits/quarries
- Site specific system design
  - Based on unique properties and circumstances of each site and waste material
  - No one size fits all – no silver bullet
  - Integrated solutions
  - Process, transport, deposition and environment

Thank you

BACKFILL PHOTOS