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BACKFILLING IN COAL MINES

By

Sam Spearing

&

Todd Kostecki

Southern Illinois University
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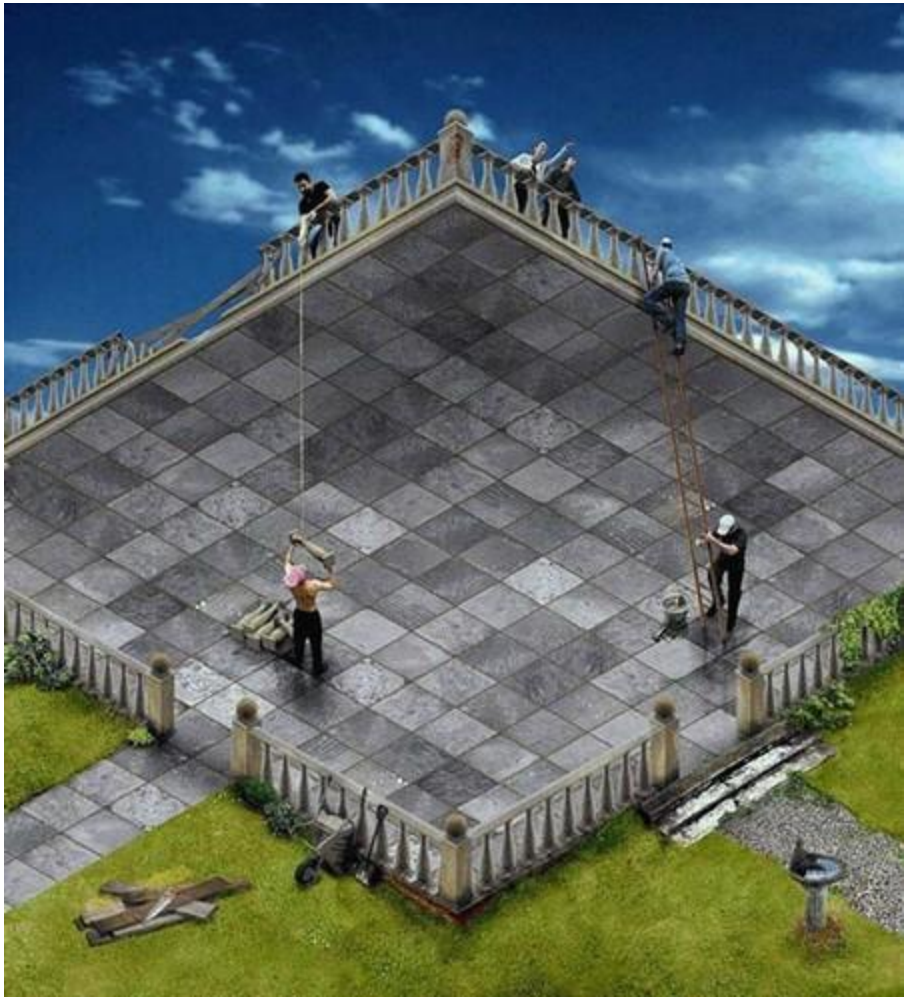
Public perception on coal in the USA



Perception is reality ! Some of the bad press is deserved, most is not.

Mining has not always been a good steward but with committed, socially responsible mining companies, the public and the government it has changed DRAMATICALLY!

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Gob/waste piles

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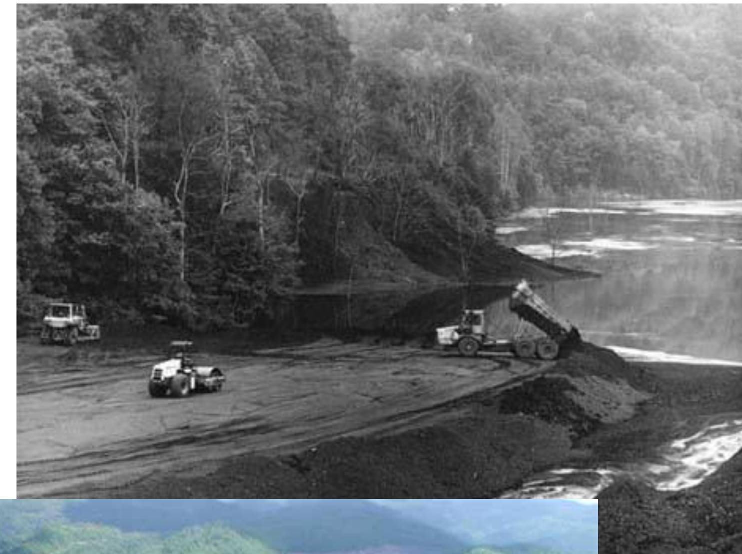
Slurry impoundments



Health and environmental concerns

Waste coal piles leach iron, manganese and aluminum pollution into waterways and cause acid drainage that kills neighboring streams.

These piles sometimes even catch fire, releasing toxic pollution into the air.

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TVA massive spill

The 60-foot-tall dam broke at a holding pond at the Tennessee Valley Authority's Kingston power plant in Roane County, Tenn., dumping more than a billion gallons of toxic coal ash onto a nearby community and into the Clinch and Emory rivers.

Coal waste disposal in the future

EPA is now regulating for the first time coal.

EPA has considered two possible options, both falling under the Resource Conservation and Recovery Act (RCRA):

- These residuals considered special wastes subject to regulation under subtitle C of RCRA, when destined for disposal in landfills or surface impoundments.
- Coal ash regulated under subtitle D of RCRA, the section for non-hazardous wastes.

The long term solution

Impoundment permitting is going to become more and more difficult.

The most efficient solution would seem to be backfilling as much as possible using the coal waste.

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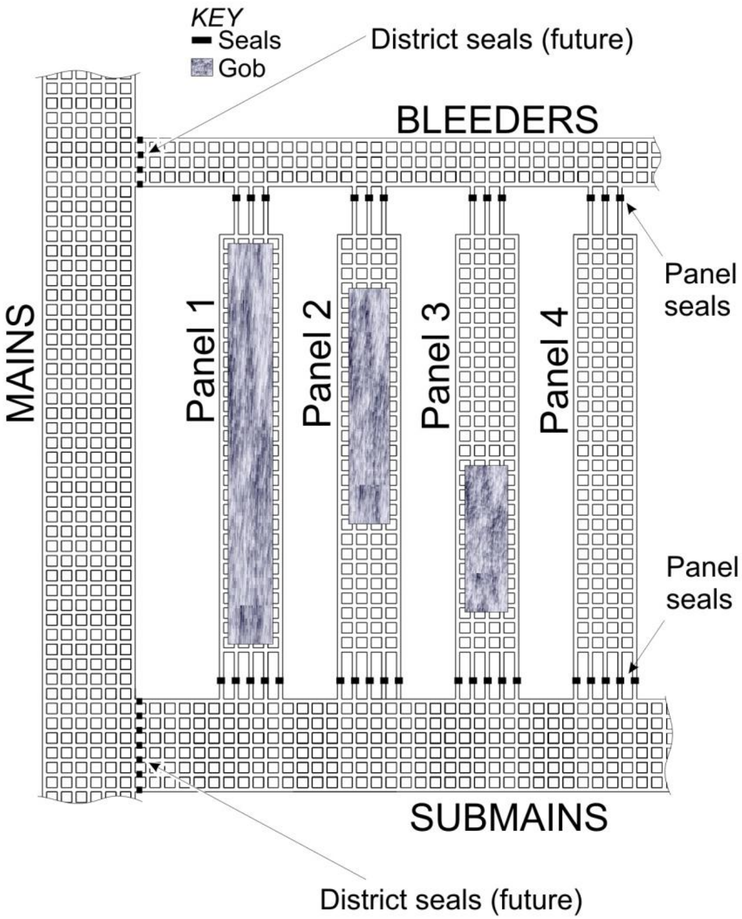
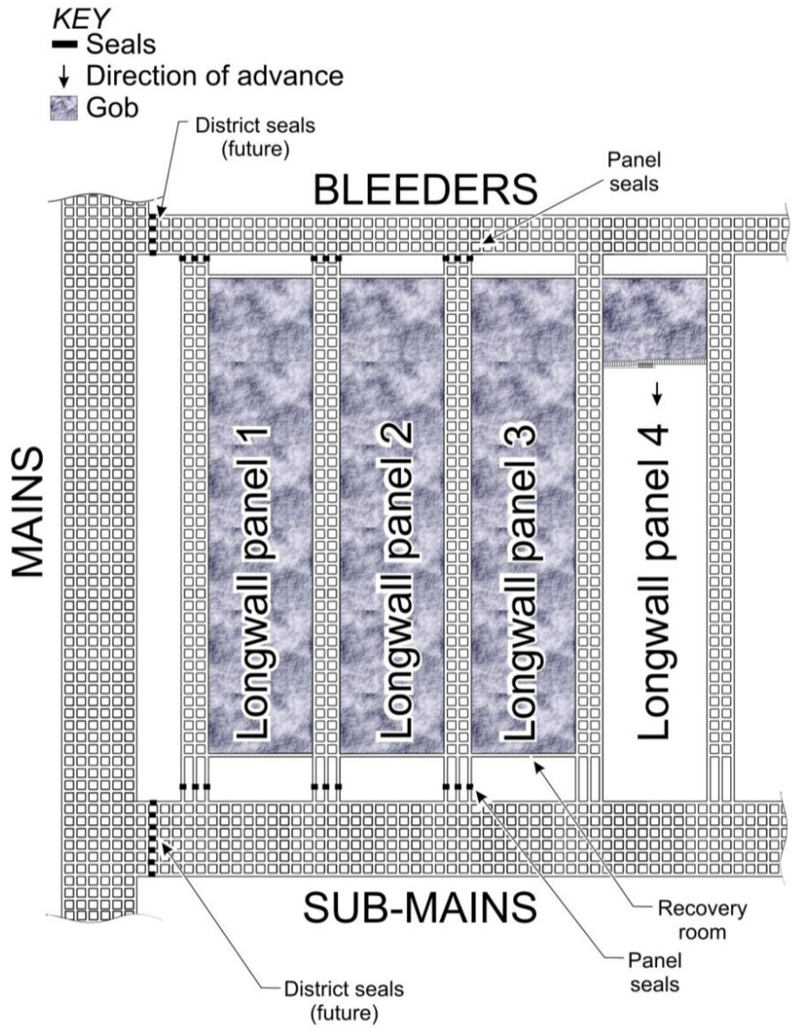
The possible advantages

- Limited or no surface waste impoundment facility requirement.
- No explosion proof seals needed as mined out sections could be filled.
- Improved extraction in continuous miner sections as in-panel pillars could be reduced (later laterally confined by the fill).
- Reduced surface subsidence in longwall operations.
- No surface subsidence with room and pillar mining.
- The potential to “strip mine” using rather highwall mining with fill to obtain higher extraction.

Explosion proof seals





Therefore the keys for success are:

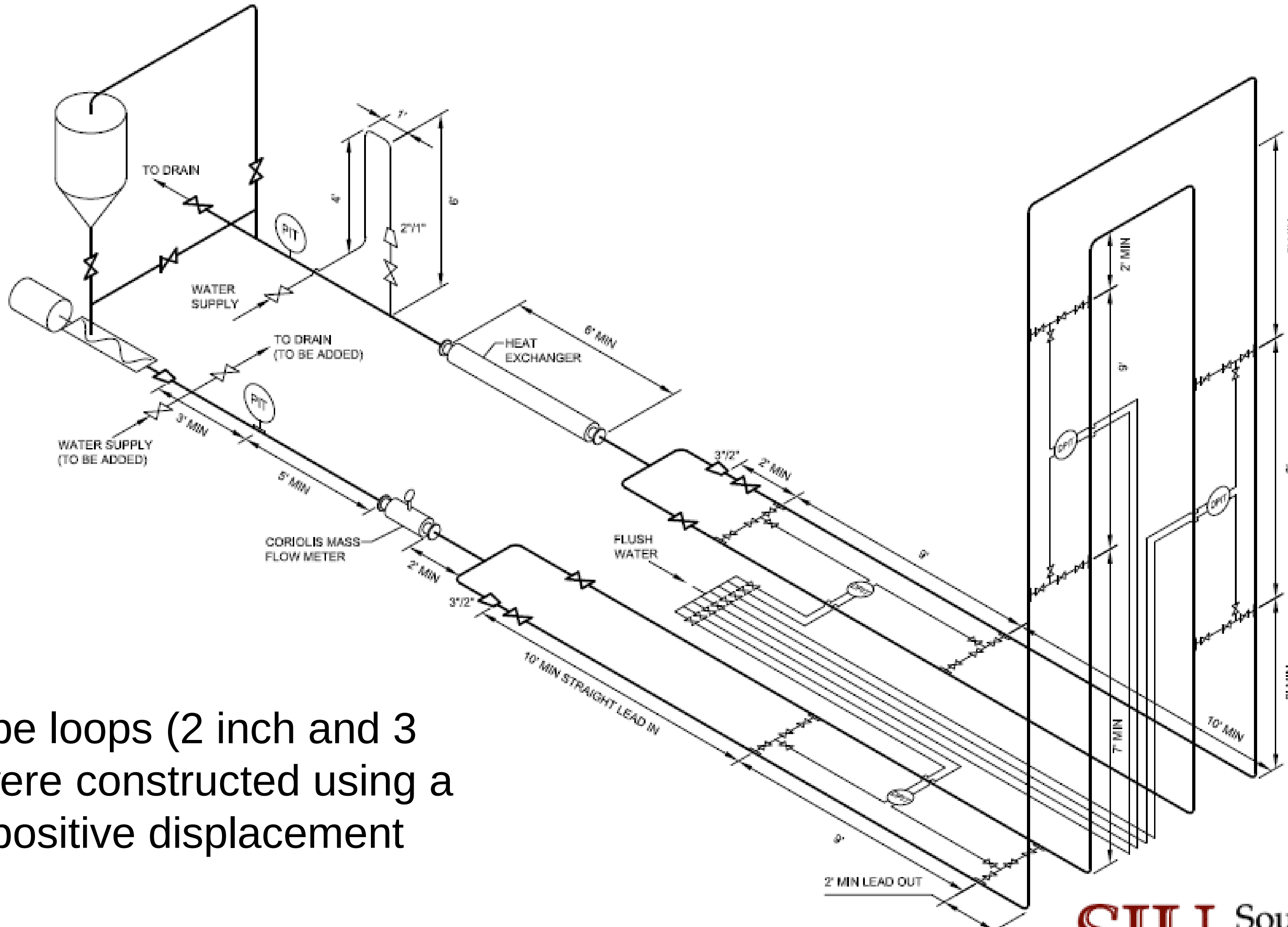
- Low water content on placement.
- Very low or “no” permeability.

Can this be done cost effectively?

Preliminary research was carried out on a candidate material to look at the technical and financial viability.

Rheology is clearly the key.

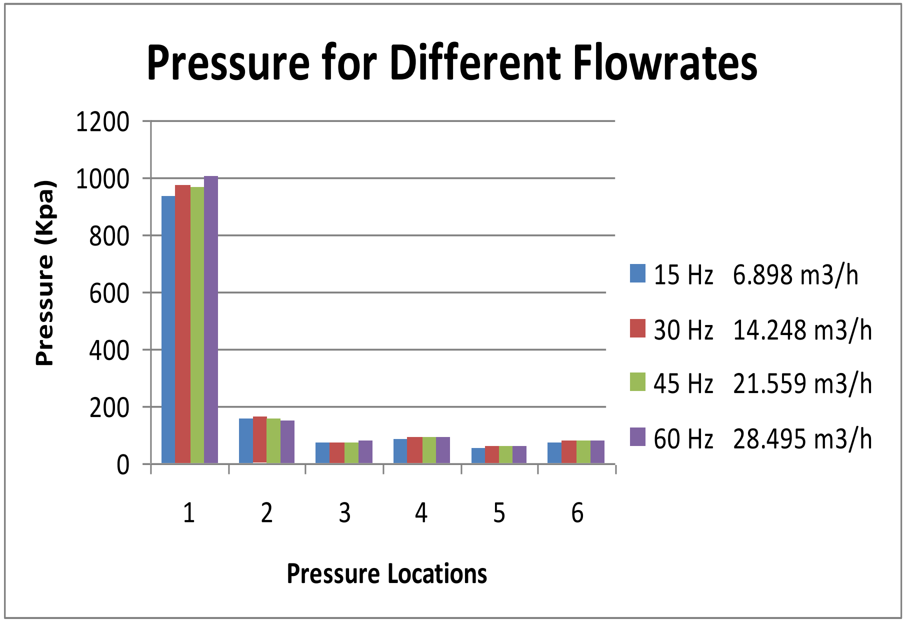
Isometric view of the MMRE pipe loops

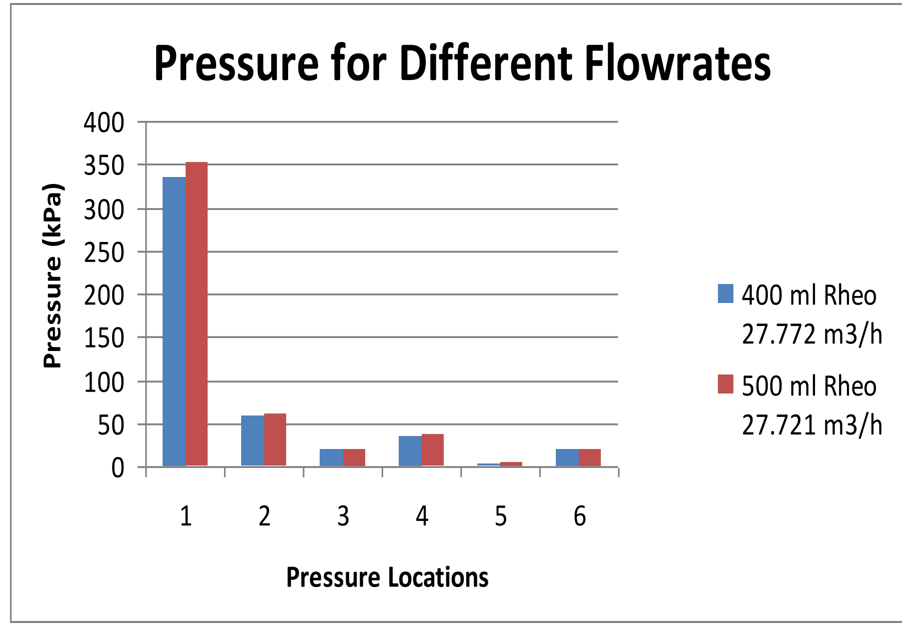


Two pipe loops (2 inch and 3 inch) were constructed using a single positive displacement pump.

During construction

Rheology test on a spiral waste





Admixtures appear essential to reduce the water content and the pressure losses which can be very high.

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Permeability

Material	Coefficient of permeability (cm/sec)	Cube compressive strength at 28 days (kPa)
Only spiral waste	$2.21 * 10^{-4}$	0
Spiral waste and 2.5% fly ash (FA) by weight	$1.58 * 10^{-4}$	Not measured
Spiral waste and 3.0% FA by weight	$1.37 * 10^{-4}$	Not measured
Spiral waste and 1.0% Portland cement (PC) by weight	$8.58 * 10^{-7}$	165
Spiral waste and 3.0% PC by weight	$2.15 * 10^{-7}$	455
Spiral waste and 3.0% PC and 3% FA by weight	Not measured	1,050
Spiral waste and 5.0% PC by weight	$7.72 * 10^{-8}$	800

These are not exhaustive tests just indicative.

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Permeability measurements on backfill

Fixed head permeameter

Water worm holing can be an issue giving erroneous results

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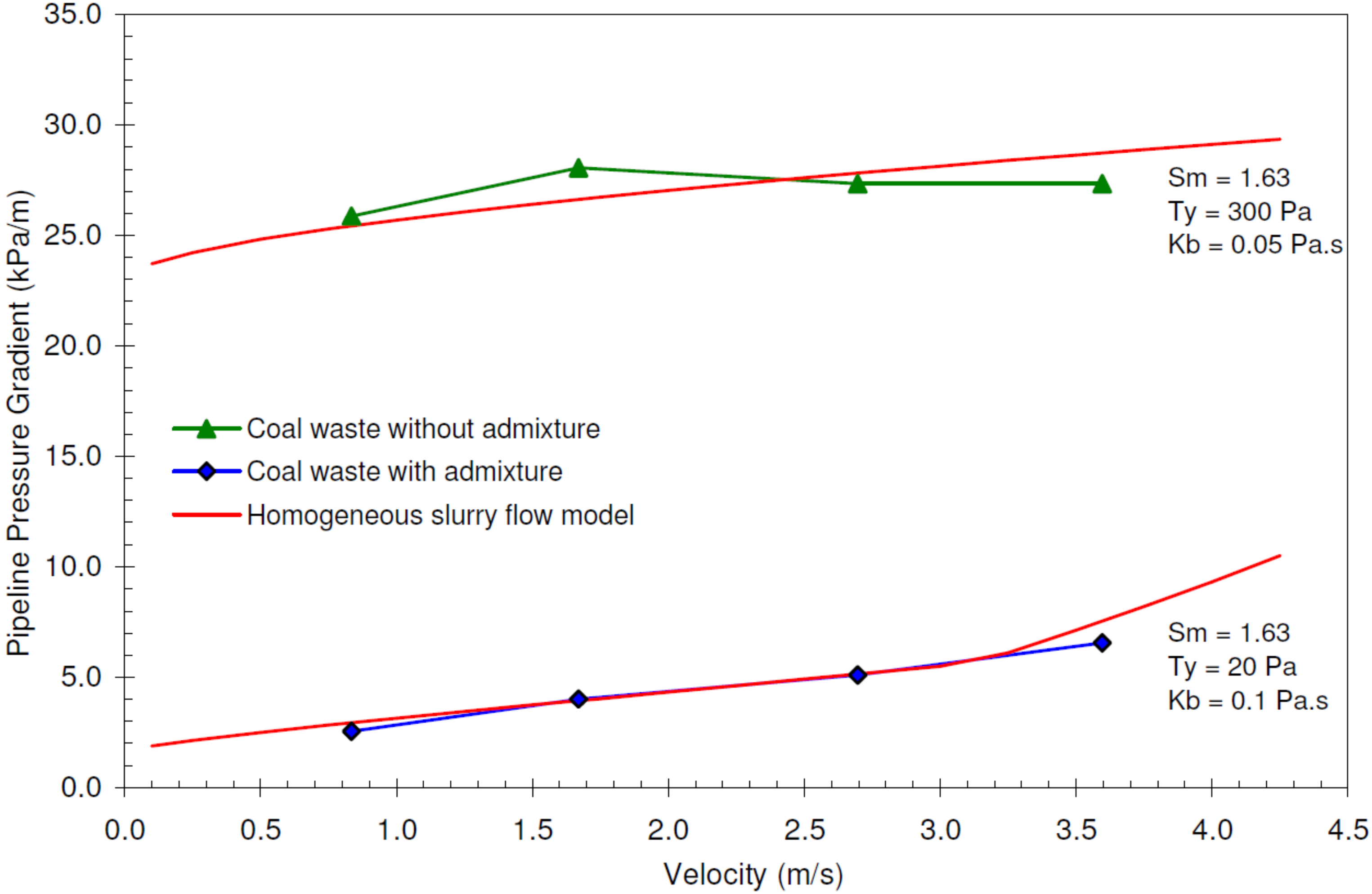
Slump tests can be useful, especially as a QC measure.

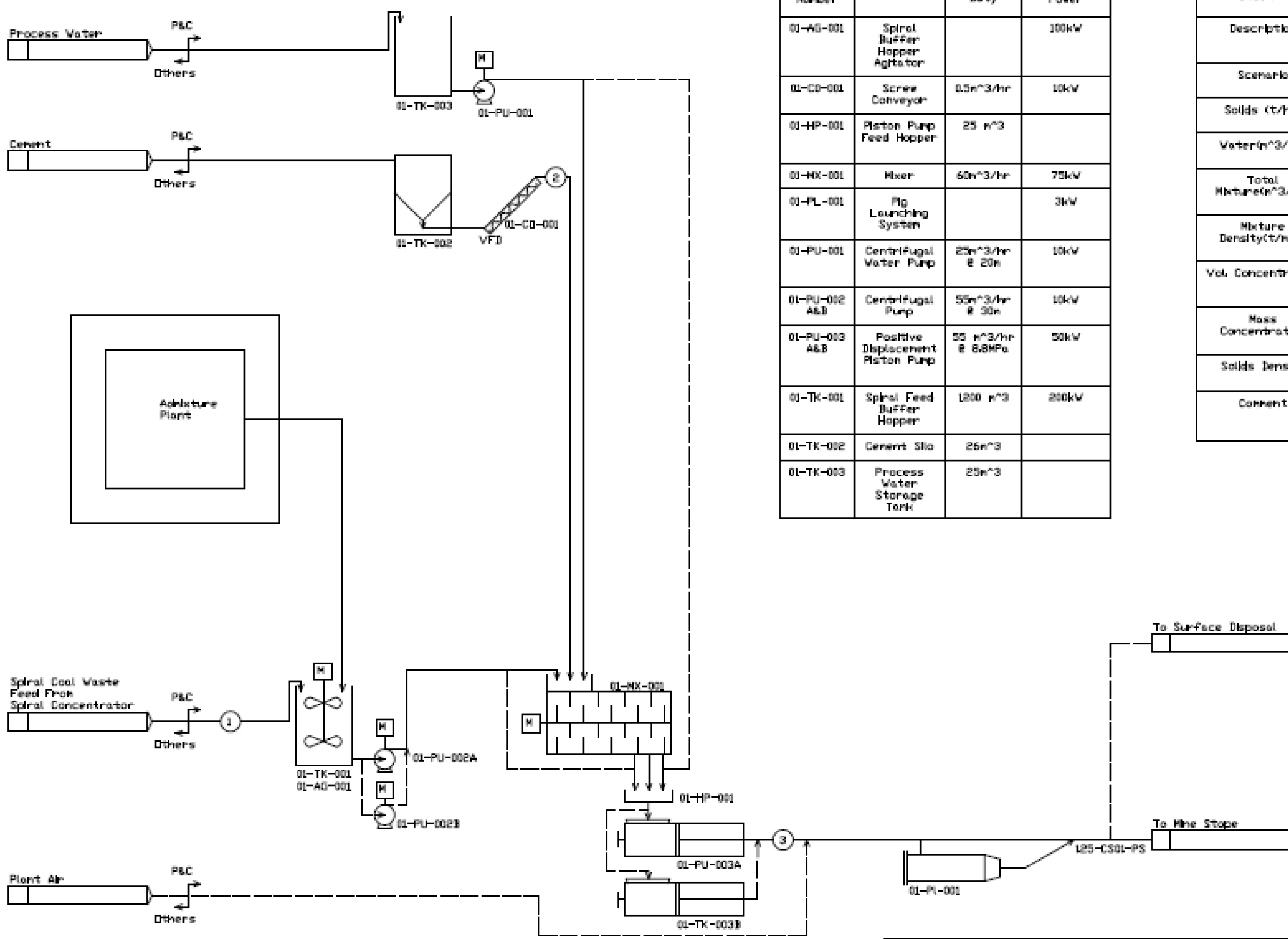
The effect of an admixture on the pressure gradient



Conceptual plant design

The cost effectiveness of backfilling is very dependent on the plant and distribution design. A theoretical layout that reflects a typical mine need was assumed to deliver a spiral waste at $50m^3/hr$, with an admixture and 3% cement by weight:

- 1,000m (0.6 miles) from the plant horizontally to a surface borehole.
- The borehole has a vertical depth of 150m (0.1 miles).
- The underground transport distance is then assumed to be 3,000m (1.9 miles).



Tag Number	Description	Capacity/ Duty	Installed Power
01-AG-001	Spiral Buffer Hopper Agitator		100kW
01-CO-001	Screw Conveyor	0.5m^3/hr	10kW
01-HP-001	Piston Pump Feed Hopper	25 m^3	
01-MX-001	Mixer	60m^3/hr	75kW
01-PL-001	Pig Launching System		3kW
01-PU-001	Centrifugal Water Pump	25m^3/hr @ 20m	10kW
01-PU-002 A&B	Centrifugal Pump	55m^3/hr @ 30m	10kW
01-PU-003 A&B	Positive Displacement Piston Pump	55 m^3/hr @ 8.8MPa	50kW
01-TK-001	Spiral Feed Buffer Hopper	1200 m^3	200kW
01-TK-002	Cement Silo	26m^3	
01-TK-003	Process Water Storage Tank	25m^3	

Steam #	1	2	3
Description	Spiral Coal Feed	Cement	Paste Backfill
Scenario	Nominal	Nominal	Nominal
Solids (t/hr)	55.3000	1.7000	57
Water(m^3/hr)	26.2000	0	26.2000
Total Mixture(m^3/hr)	49.5000	0.5000	50
Mixture Density(t/m^3)	1.6400	3.1500	1.6600
Vol. Concentration	47.12%	100%	47.60%
Mass Concentration	68.00%	100%	68.60%
Solids Density	2.3700	3.1500	2.3900
Comment		Add 3% Cement by Mass	

Itemref	Quantity	Title/Name, designation, material, dimension etc			Article No./Reference	
Designed by M.TREINEN		Checked by	Approved by - date	Filename	Date 04/16/10	Scale NTS

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Spiral Coal Waste Backfill Plant
Process Flow Diagram

Edition	Sheet

Cost comparison

Conventional impoundment:

$2.29/m³

When the EPA regulations goes into law, these costs will increase.

Backfilling:

$7.20/m³

Bulk use of the admixture should reduce the cost to less than $6.00/m³.

The other advantages have not been costed.

The situation world wide

- Paste filling has been used behind longwalls in Polish and German coal mines for decades to reduce subsidence.
- A high density system is being implemented on a longwall mine in Australia.

More are looking at it……

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Conclusions

Coal is essential for power generation internationally.

With the new EPA regulations, permitting new impoundments will become even more difficult and considerably more costly.

Backfilling such that water table contamination is not a concern appears viable.

Any questions?

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