Dry Tribo-electrostatic Separation

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Titan CEMENT: Who we are…

Titan Group
is an international
cement and building
materials producer

Safety
Integrity
Know-how
Value to the customer
Delivering results
Continuous improvement
Corporate social responsibility

Founded in 1902

Listed: Athens Stock Exchange since 1912

Listed: Brussels & Paris Euronext since 2019

14 cement plants in 10 countries

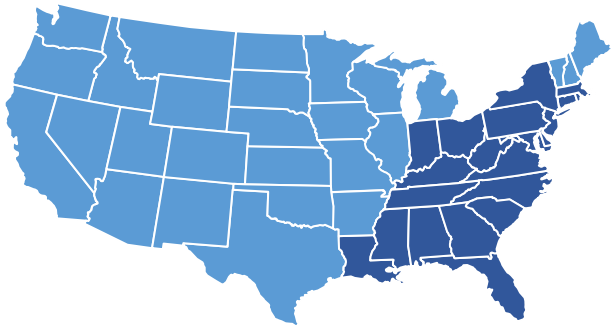
5,400+ employees; 2.5b EUR turnover

Titan America at a glance:

- A premier building materials producer
- Business activities in the Eastern US
  - Cement
  - Ready-mixed concrete
  - Block
  - Construction aggregates
  - Import/export and terminals
  - Fly ash
- Soon to be listed on NYSE

TITAN AMERICA

HQ in Norfolk, VA



2023

2250+ strong
$1.6 Billion Turnover

TITAN AMERICA

Who are we? What do we do? History of Separation

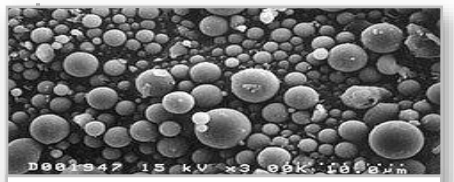
Technologies

Startup founded by MIT engineer to develop Triboelectric Belt Separator.

Titan America acquires ST. First international project in Scotland.

2014: Technology sales/licensing as a stand alone company “STET”

1989 | 1995 | 2002 | 2011 | Currently

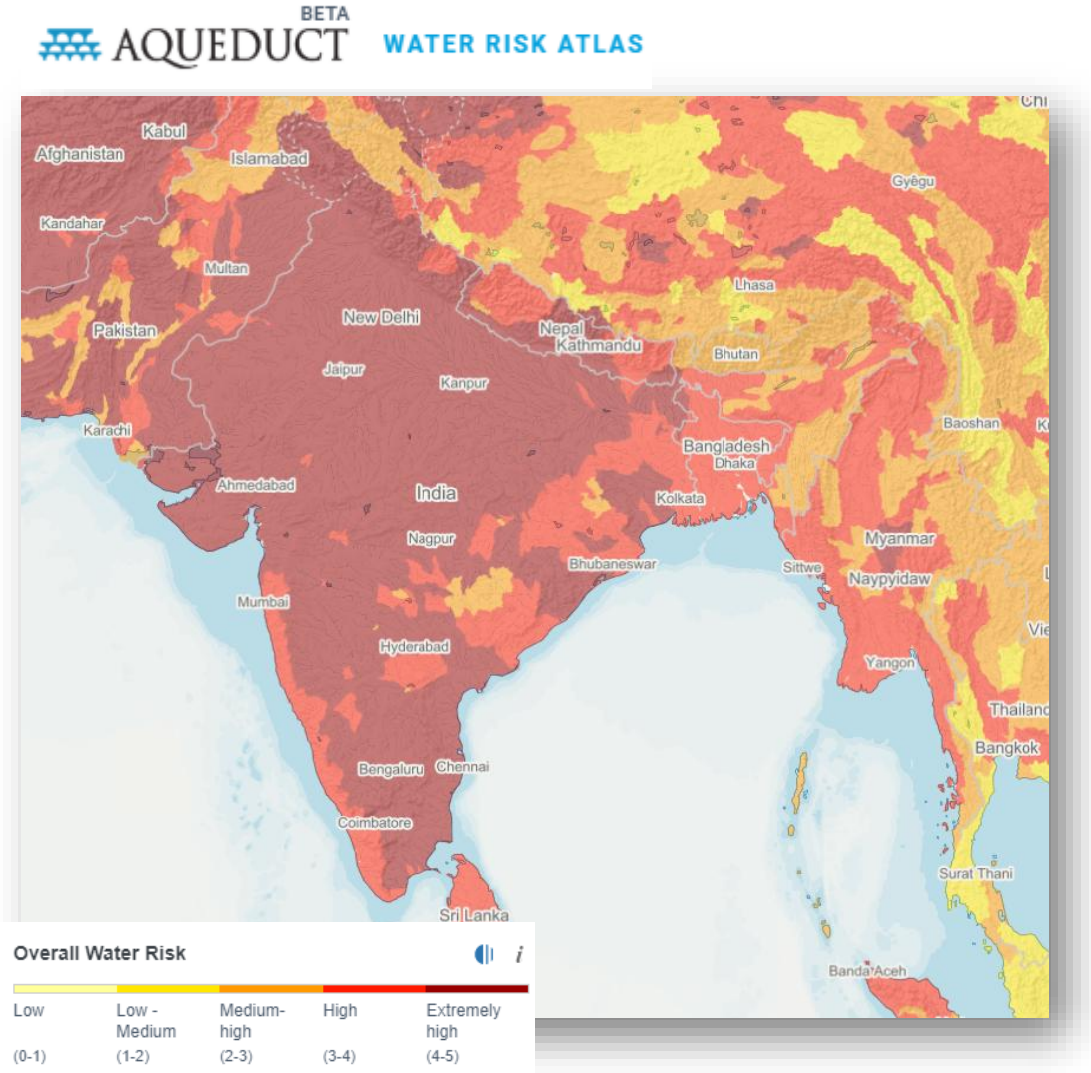


ST begins commercial fly ash processing.

Fly ash installations in 7 countries: USA, UK, Canada, Poland, Republic of Korea, Japan & Philippines.

Our Vision: Water-Free Mineral Processing

- Vast Quantities of Fresh Water are used Each Year for Minerals Processing.
- Estimates range from 1,000 – 4,000 liters / ton of ore.
- Although a Relatively Small Consumer of Water (<1% Overall), the Mining Industry will Increasingly be Pressured to Reduce Fresh Water Consumption.
- Agriculture and Residential Users will take Priority.
- South-East Asia, and India Especially, face a critical shortage of fresh water.

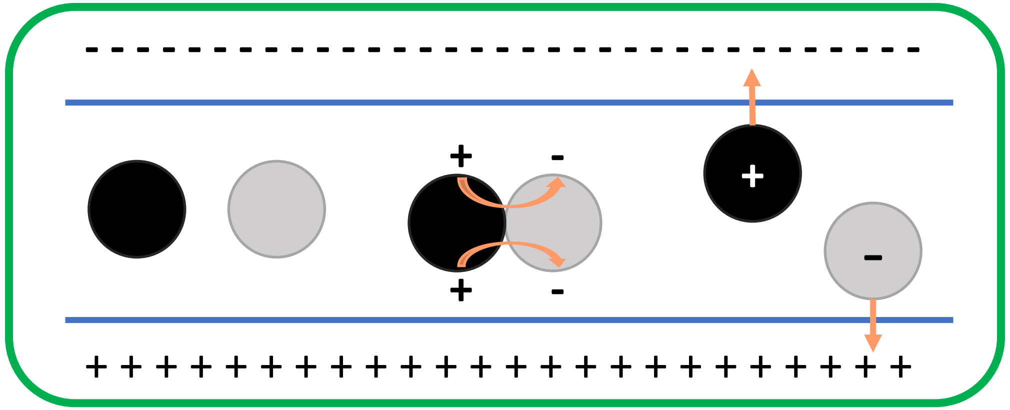


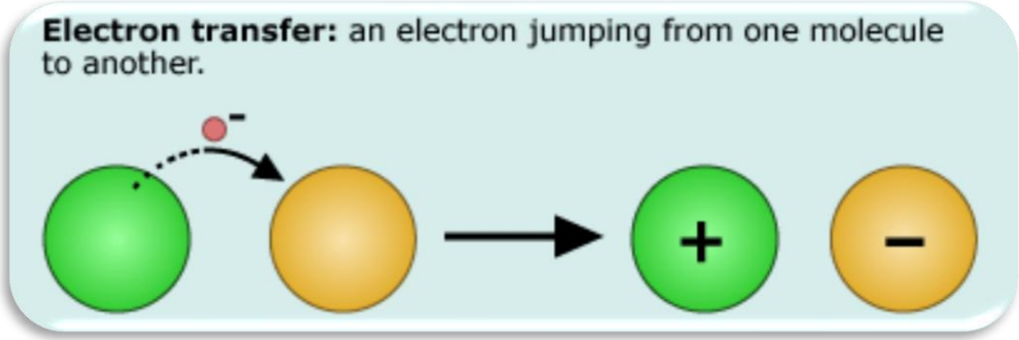
Source: The Water Risk Atlas (https://www.wri.org/aqueduct)

Electrostatic Separation – Tribo-charging

Tribo-charging (Contact Charging, Friction Charging)

- Particles charge by contacting each other





- Positive (+) or Negative (-) charge depends on difference in material properties
- Electrostatics applied in: **Flue gas treatment** (removal of particles); **Plastic recycling** (metal, plastic, wood sorting); **Mineral separation** (purity improvement); **Fly ash separation** (removal of unburnt carbon)

Project Development Phases for Minerals

Benchtop Separator

Proof-of-Concept
Low Cost
Small Sample

Pilot Plant Separator

Prediction of Commercial Results
Moderate Cost & Sample

Commercial Separator

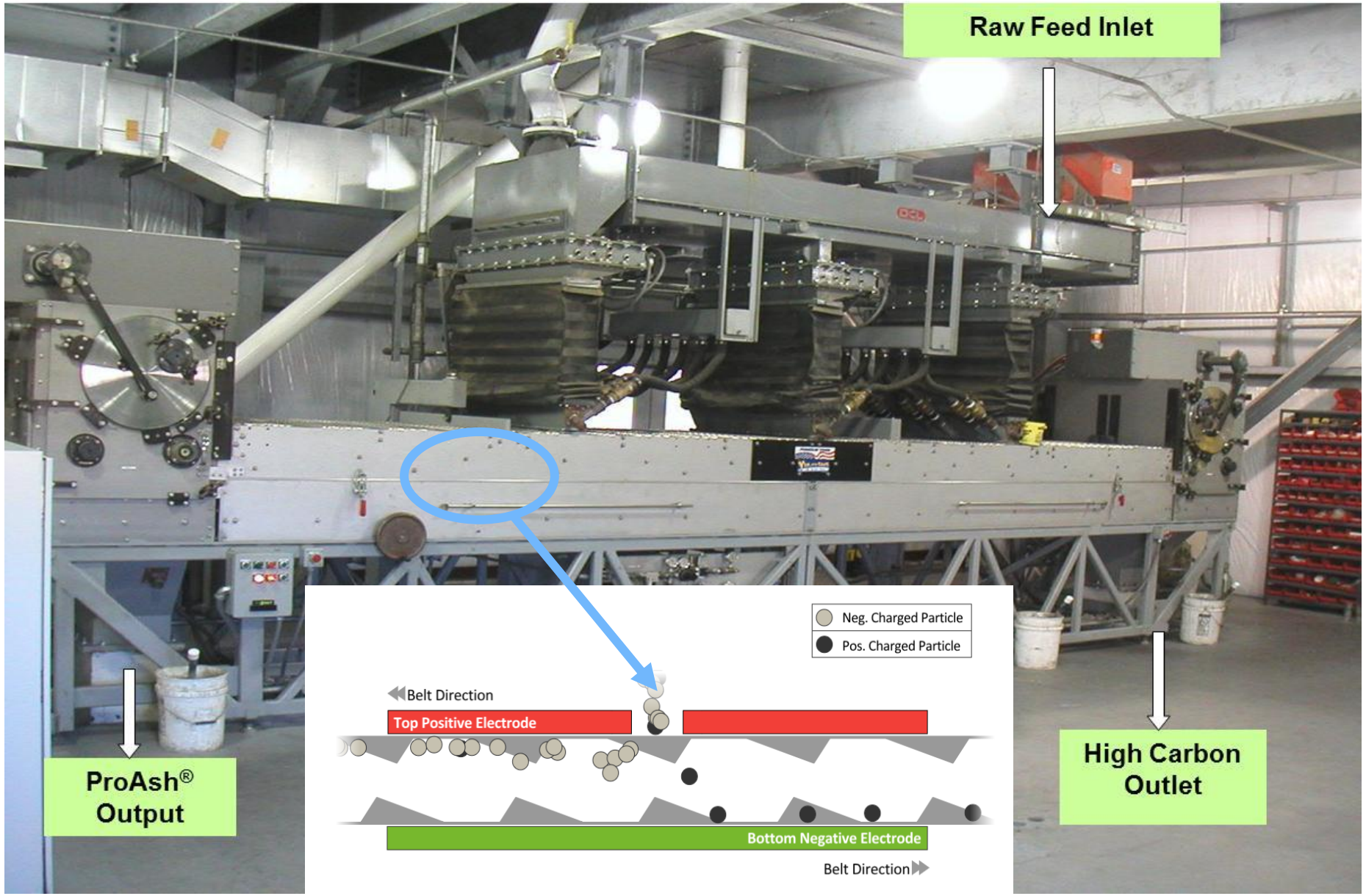
Production

Mobile M6-c Pilot Plant Separator

Mobile M6-c Pilot Plant Separator

- Configured to Run 10 kg Batches of Feed
- Feed Preparation & Mixing Equipment Included
- Requires Dust Collection to be Supplied by Customer
- Can be Converted to Semi-Continuous

The ST Triboelectric Belt Separator



- Short residence time (~1s)
- High electric field strength with moderate applied voltage (typical 8-20 kV)
- High efficiency multi-stage separation through charging & recharging
- Particles accepted up to 1mm

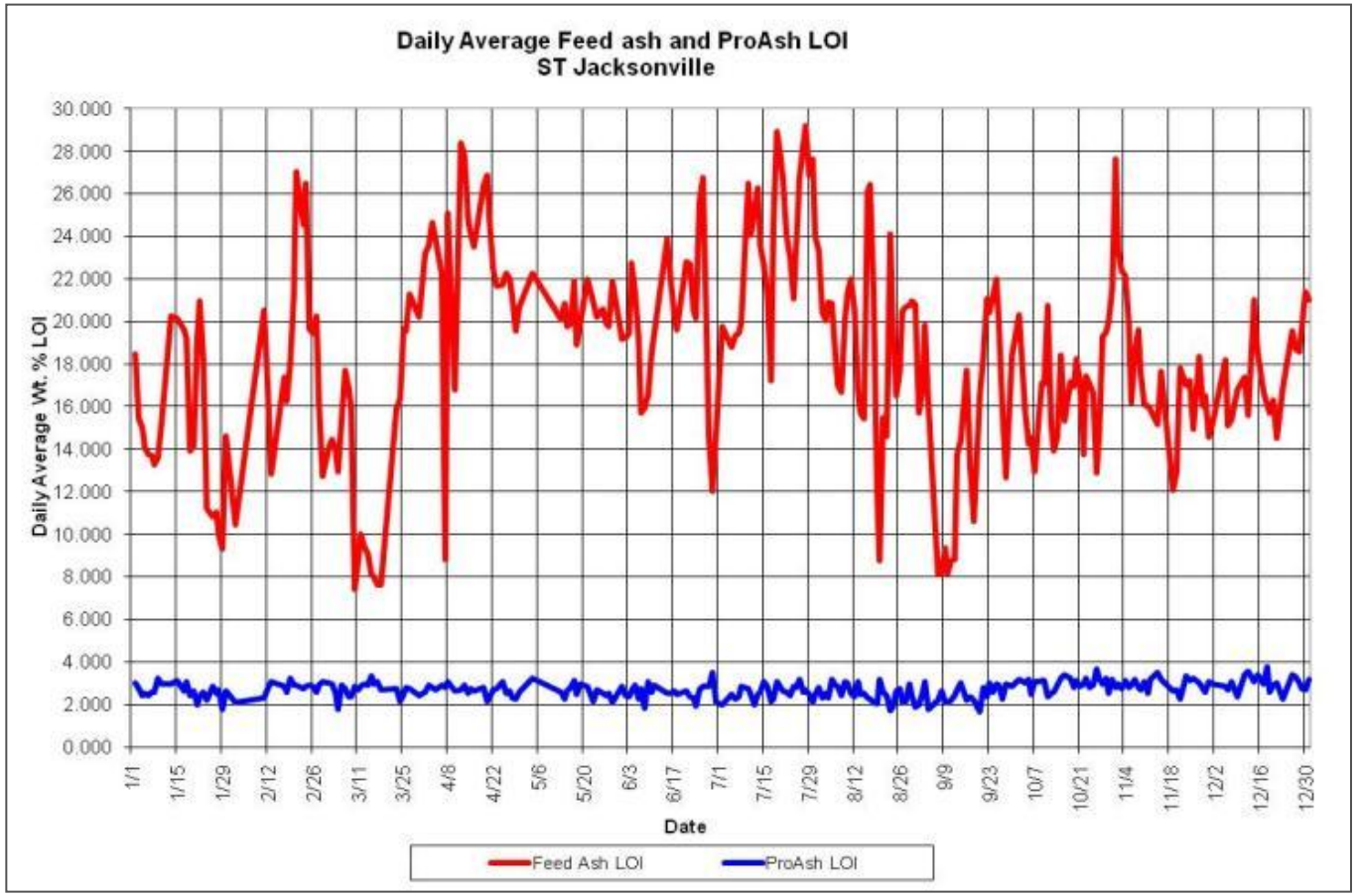
Introduction to ST Equipment & Technology

- STET Offers a Robust and Commercially Proven Technology to Beneficiate Minerals *Without the Need for Water*.
- High Rate (up to 50 TPH)
- Commercially Proven Processing Technology
- Low Energy Consumption (1-2 kWh/ton Feed)
- Consistent Product from Highly Variable Feed Material
- Very Efficient at Fines and Ultra-Fines

Fly Ash Separator, South Korea

STET Separator Advantages

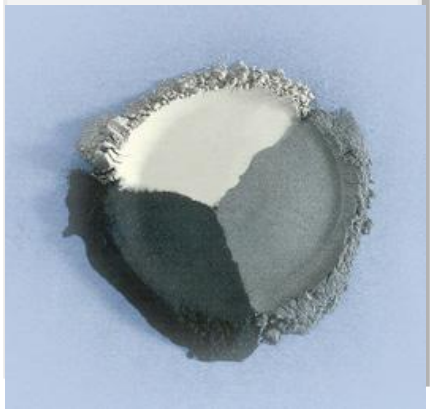
- Consistent Product from Highly Variable Feed Material – Process is Rapidly Adjustable to Keep Consistent Product.
- Power Plant Boiler Operations Influence Fly Ash Quality.
- STET Separator Takes Inconsistent & Highly Variable Feed from Power Plants and Generates Consistent Quality Fly Ash Product.



Application – Increase Specific Gravity (SG) of Barite

- STET M24 Separator Operating at Ramadas Minerals Pvt. Ltd. barite grinding plant near Kodur India

Example Applications

	Calcium Carbonate	Talc	Barite	Fly Ash
Feed	▪ 9.5% SiO_2	▪ 58% Talc ▪ 42% Magnesite	▪ 200,000 TPY ▪ 82%BaSO4 ▪ 3.78 (SG)	▪ 8 % - 25% LOI 
Results	▪ < 1% SiO_2 ▪ 89% $CaCO_3$ Recovery ▪ Improved Brightness	▪ 95% Talc ▪ 77% Recovery ▪ 88% Talc ▪ 82% Recovery	▪ 92% BaSO4 ▪ 4.21 SG ▪ 74% Recovery	▪ Processed ash: ▪ 2.5% LOI 

Application – Calcium Carbonate

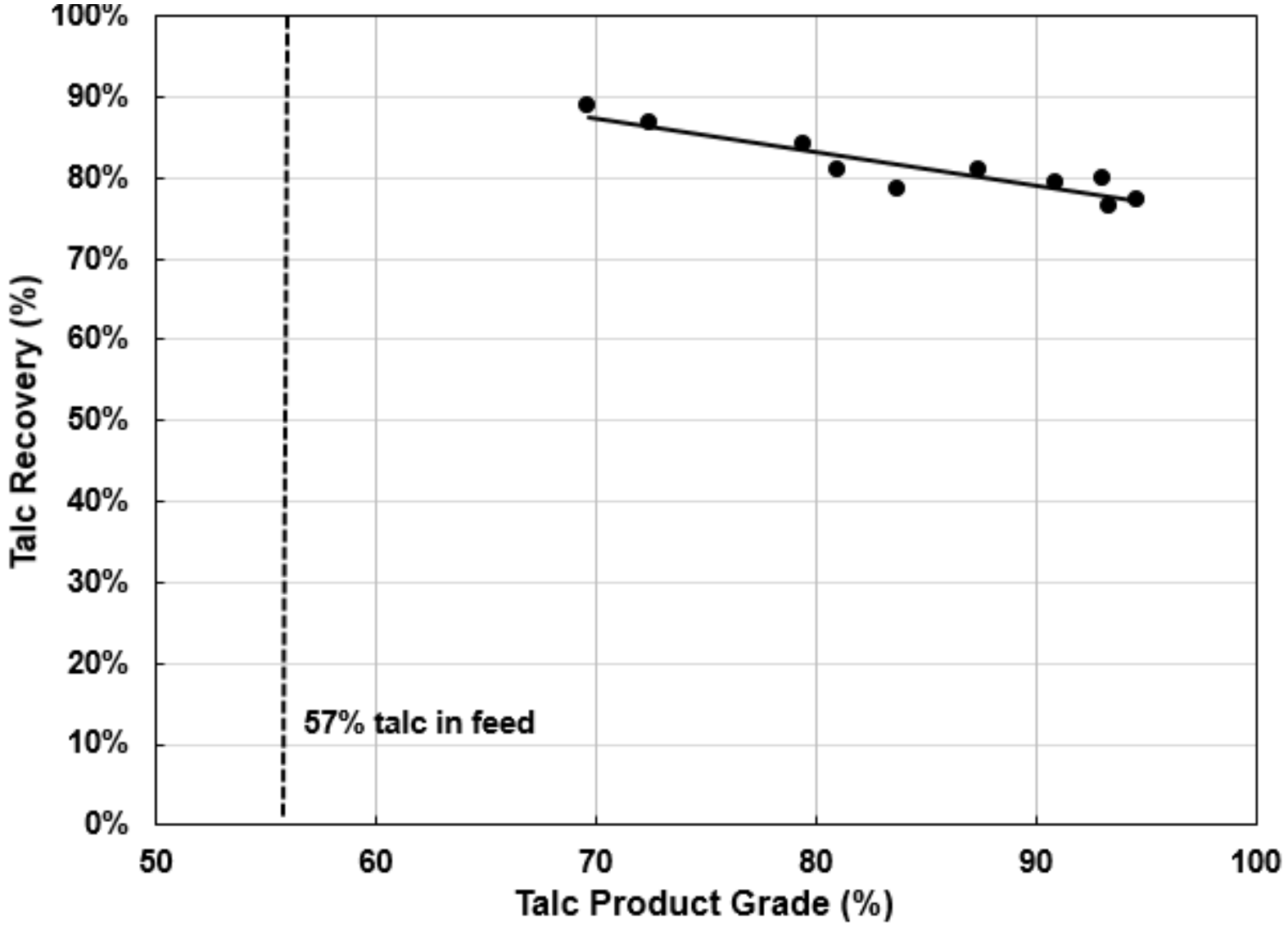
- Full Scale Processing Results from Commercial STET Separator.
- Brightness Improvement Observed.

- ✓ **Highly Selective Separation – Purification of Calcite**
- ✓ **Reduction in Acid Insoluble (%AI), mostly silicates**
- ✓ **Substantial Brightness Improvement**

Month	Feed Grade (%AI)	Product Grade (%AI)	Product Mass Yield (wt.%)	Calcite Recovery (%)	AI Rejection (%)
Feb	3.3%	0.6%	86%	89%	84%
March	3.7%	0.6%	89%	92%	87%
April	4.1%	0.6%	89%	92%	88%
May	4.0%	0.7%	89%	92%	84%
June	4.7%	0.6%	89%	93%	89%

Application – Talc

- Rejection of Magnesite and Dark Color Contaminants from Talc.
- Talc Purity of up to 94% Observed.
- Brightness Improvement Observed.



Application – Fine Iron Ore

- STET Performed Bench Scale Separation of Finely Ground Iron Ore
- Iron Ore Samples from Multiple Sources Tested:
  - Ground & Dried Tailings from WHIMS
  - Run-of-Mine
  - Itabarites
- Very Selective Rejection of Silicates
- Very Efficient at Ultra-Fines (<20 µm)
- All Tests at Bench Scale → Grade & Recovery to Improve at Pilot Scale

Application – Fine Iron Ore

Exp	Feed Fe wt.%	Product Fe wt.%	Absolute Fe Increase %	Fe Recovery %	SiO2 Rejection %	D10 (µm)	D50 (µm)	D90 (µm)
1	39.2	50.6	+11.4	91.5	63.9	5	23	59
2	39.4	60.5	+21.1	50.8	96.0	5	23	59
3	30.1	48.0	+17.9	70.6	84.6	1	18	114
4	29.9	54.2	+24.3	56.4	93.7	1	18	114
5	47.0	50.2	+3.2	96.6	35.3	17	62	165
6	21.9	48.9	+27.0	41.2	96.6	17	62	165
7	47.6	60.4	+12.8	85.1	96.9	17	62	165
8	35.1	44.9	+9.8	89.0	54.2	3	61	165
9	19.7	37.4	+17.7	76.0	56.8	5	103	275
10	54.5	62.5	+8.0	86.3	77.7	5	77	772
11	54.6	66.5	+11.9	82.8	95.6	8	45	179

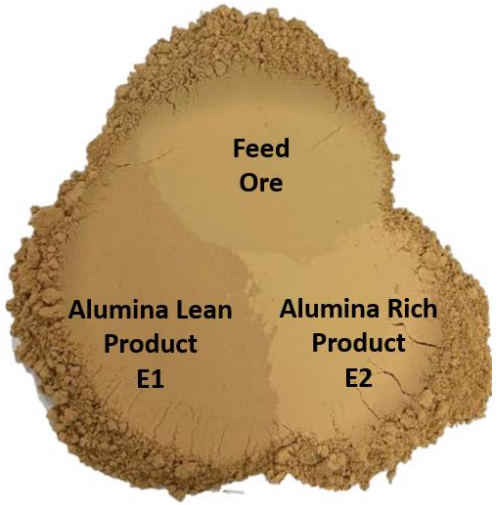
Iron Ore Summary

Technology	Description	Particle Size Range (µm)
LIMS (Low Intensity Magnetic Separation)	Wet / Dry for Magnetite Well established	1000-40
HIMS (High Intensity Magnetic Separation)	Dry for Hematite Well established	1000-40
WHIMS (Wet High Intensity Magnetic Separation)	For fine Hematite Operationally challenging	300-20
Reflux Classifier	Dynamic settling technology	300-38
Selective Flocculation	Feed preparation for flotation High OPEX (reagents)	150-15
Flotation	High OPEX (reagents) non-selective with fines <4% SiO2 achievable	150-15
STET	<4% SiO2 achievable Highly selective with fines & ultra-fines	300-1 **<20**

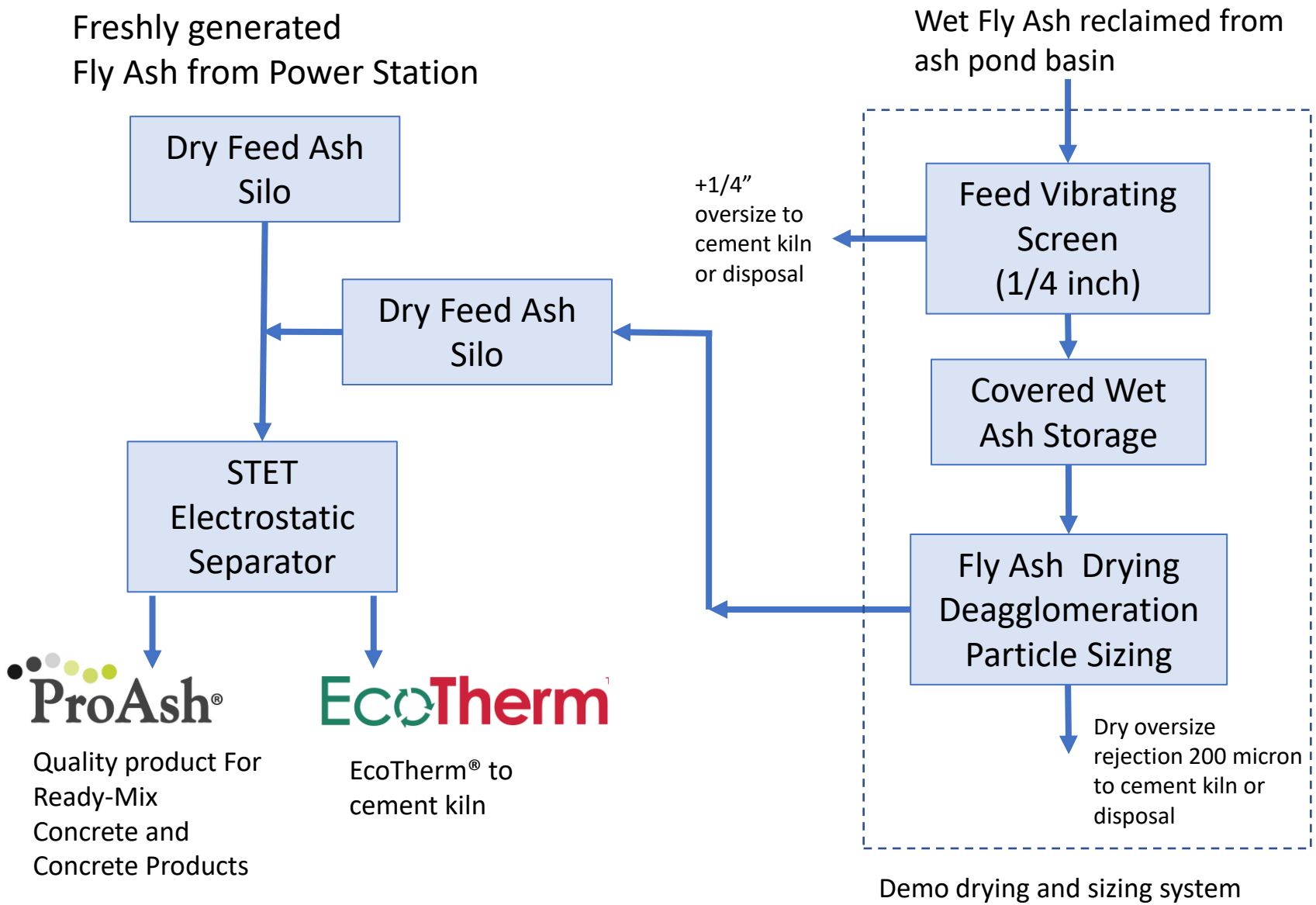
Application – Bauxite

Expected Benefits for Aluminum Refiners:

- Reduce Silica (SiO_2) to Refinery by 50-80%
- Savings of $20-30 USD per Ton of Alumina Product
  - Caustic Soda Reduction
  - Red Mud Valorization – Convert up to 40% of Red Mud to Cement Grade Bauxite
  - Reduce Volume of Bauxite to Refinery (Water & Energy Reduction)
- Extend Quarry Reserve Life
- Increase Metallurgical Grade Reserves
- Reduce Dependence on Imported Bauxite



Demonstration Flowsheet for processing ponded basin fly ash at Brunner Island



ST built a Demonstration fly ash reclamation project at an existing fresh fly ash ST processing plant at Brunner Island Power Station

Feed ash drying at 5 tph
Separation at 30 tph
Equivalent to production fly ash processing

ProAsh® from Basin reclaimed fly ash

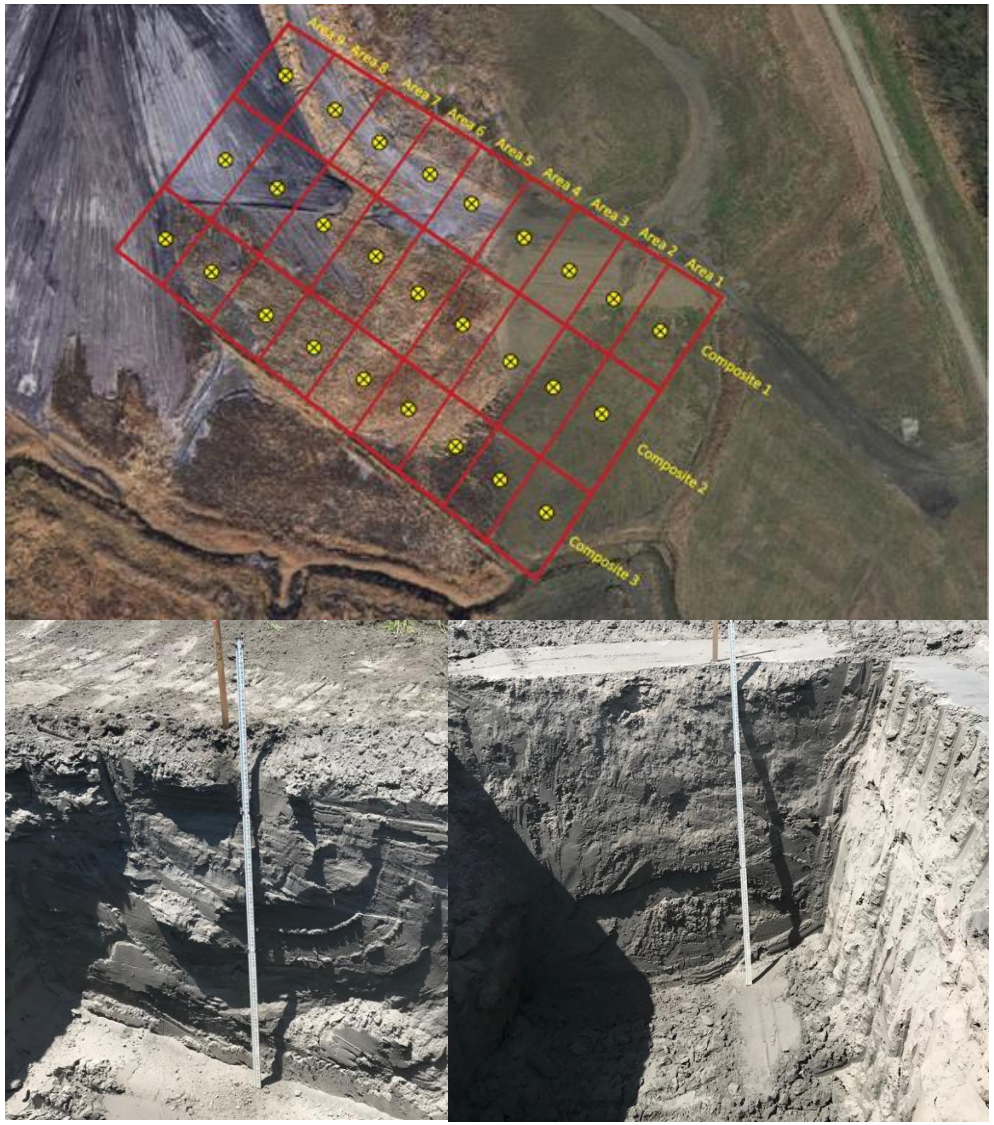
Harvested, screened, and dried Basin feed fly ash

EcoTherm® from reclaimed fly ash

Harvested Fly Ash Processing Plant

Ash reclaimed from dewatered ash basin for processing by ST

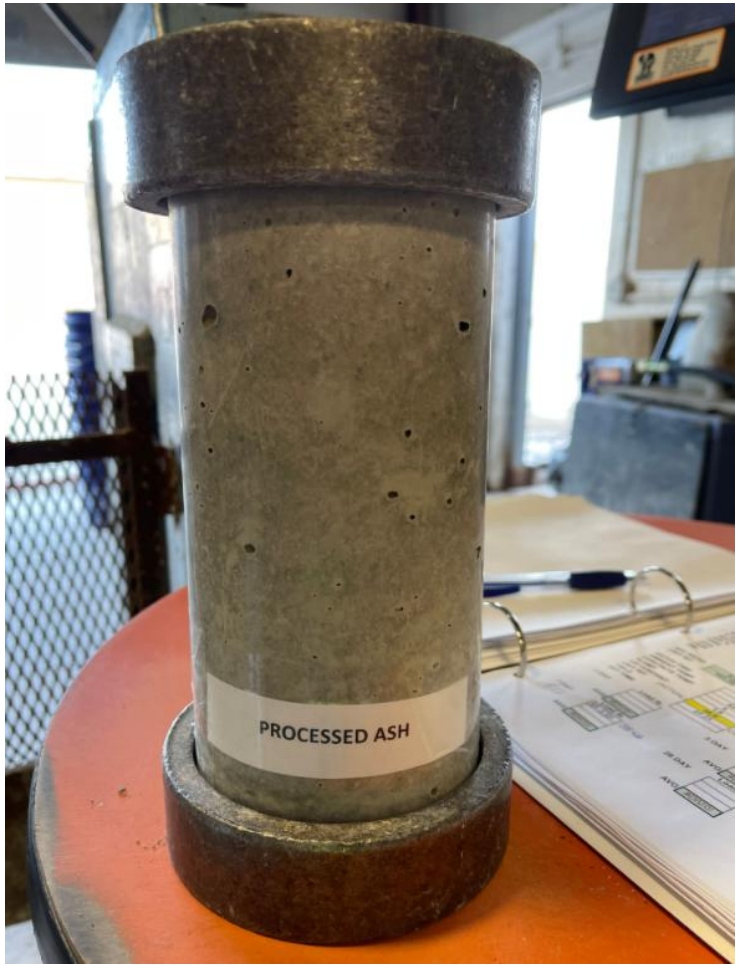
Brunner Island Basin Test Sample Grid 27 total pits



Unprocessed Feed Ash from Basin Test Results - Averages for truckload samples by basin area no.		
	Avg Moisture wt %	**Avg LOI wt% dry basis**
ASTM C618 spec	3% maximum	6% maximum
Basin Area Number		
1	19.7	9.0
2	20.5	10.0
3	20.6	8.8
4	19.0	11.4
5	21.5	12.0
6	21.6	9.0
7	22.2	8.7
8	20.4	10.9
9	18.5	11.0

- All feed basin samples do not meet ASTM C618 specifications without drying and LOI reduction and fineness improvement

Concrete Testing for ProAsh produced from basin and from fresh ash



Concrete strength testing indicated equivalent performance for ProAsh® generated from fresh feed ash and reclaimed basin ash source

Thank You

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