Innovative moisture reduction via non-thermal drying

Paul Vermeulen B.Eng Met, MAusIMM
24 May 2018

Traditional drying methods

Heating – 5400 kCal/1% moisture in ore

Vacuum/disk/pressure filters – can only dewater, cannot dry.

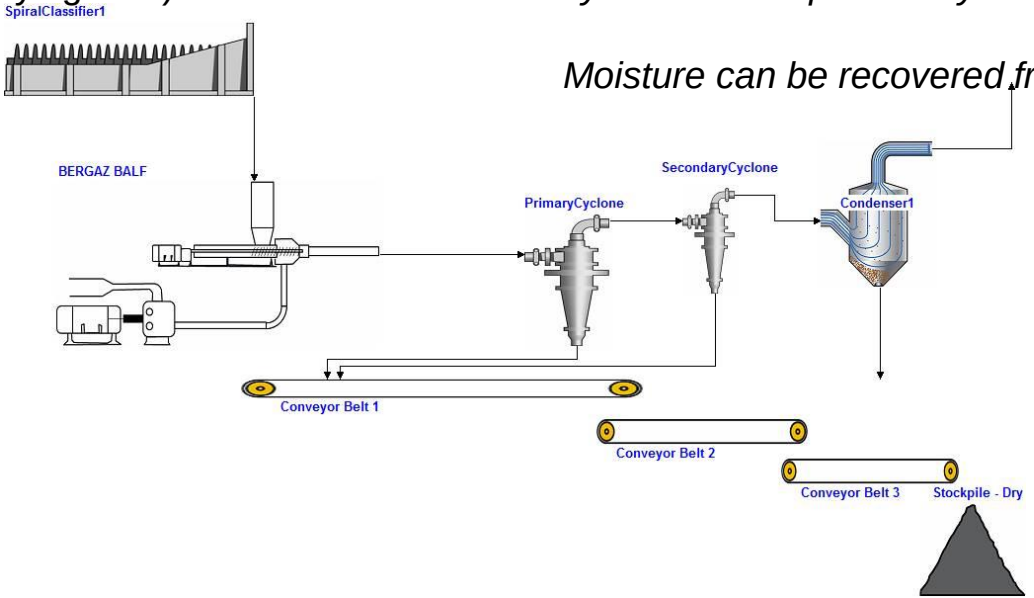
Non-thermal drying – as low as 250 kCal/1% moisture in ore (5% of conventional drying cost)

The Bergaz BALF system

Patented Boundary Air Laminar Flow (BALF) system developed by Bergaz LLC of Utah, U.S.A.

Roots blower provides low pressure high volume air into chamber, defined length of straight pipe and cyclone/s to separate dry material from humid air.

Moisture can be recovered from humid air if required.



Commercial applications

Drying and transport of glass beads – fibre glass manufacture (>20 years)
Drying of coal
Drying of sand
Drying of garnet

Iron ore drying and beneficiation test work performed by seven iron ore companies so far. Purchase order for first commercial 150 tph iron ore drying unit placed February 2018.

>>350 tph drying unit engineering and procurement in progress.

Strong interest from companies specialising in lithium, gold, bauxite, base metals since 2014.

Public iron ore fines results

14% moisture to 6.5% moisture in single pass.
6.5% moisture to 4.5% moisture in second pass.
4.5% moisture to 3.4% moisture in third pass.

Dust Extinction Moisture ~5.5%, so no need for more than one pass.

Lump ore – not as efficient as only surface moisture is removed, not inherent moisture. Surfaces still dry and suitable for screening.

Beneficiation of iron ore A
Initial moisture = 4.5 to 7.0%
Processing yield = 80% Dry basis

	Fe	SiO_2	Al_2O_3
Feed	54.8	8.4	3.2
Cyclone underflow	56.4	7.5	2.6
Cyclone overflow	48.5	10.4	4.8

End moisture = 2.5 – 3.0%. Water added back in to 6% for Dust Extinction purposes.

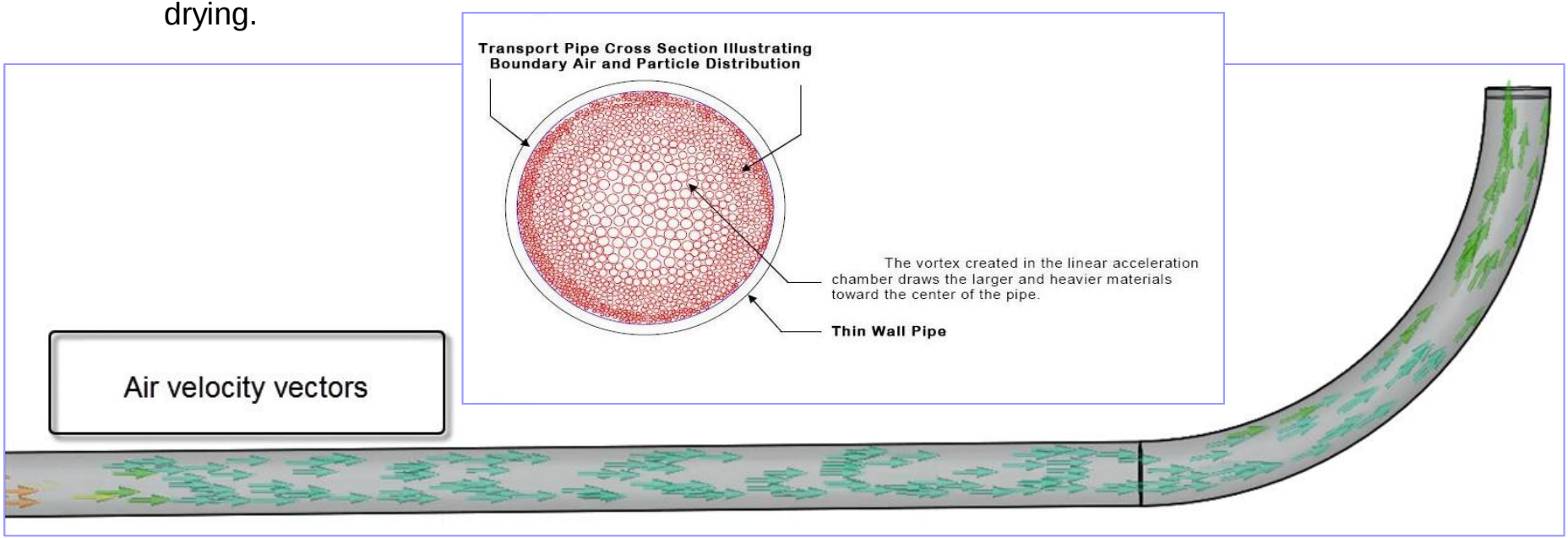
Drying of Australian coal B
Initial moisture = 4.5 to 7.0%
Processing yield = 80% Dry basis

Moisture	Feed Moist	Underflow Moist	Overflow Moist	Ash
Sample A	21.5	5.2	0.8	9.7 -> 9.5
Sample B	21.1	2.5	0.8	9.7 ->9.6


Sticky Feed Coal


Dry Product Coal

- CFD modelling of system shows laminar flow regime of air, and solids (100 micron, 1mm and 10mm dia) remaining mostly in centre of straight pipe length during dilute phase transport and drying.



- Separation based on density can also be performed in primary cyclone.

CAPEX

- ~USD1-2m per 100 tph (Application- and scale-dependent)

OPEX

- Electricity 2-10 kWh/t (dependent on scale and application)
- Standalone system - Front End Loader and operators
- Integrated system – e.g. conveyor fed and conveyor offtake.

Savings

- Site-dependent
- Examples include lower transport costs, better customer acceptance, better material handling properties.

Scalability

Material size 2 micron to 25mm
Machine sizes 1 tph to 500 tph (largest installation so far)

The key to the low OPEX

The blower package operates at a low pressure. Electricity consumption is determined not by the air volume moved, but primarily by the amount the air is compressed.

Roots Blower 1821J	4 PSI	6 PSI	8 PSI	10 PSI	18 PSI
CFM	8658	8507	8380	8268	7905
BHP	206	284	362	440	752
BHP/1000 CFM	23.8	33.4	43.2	53.2	95.1

- Queensland project – copper concentrate is packed in bulka bags, transported 150km by road, shipped to China via ocean freight.
- Assumptions:
- Concentrate moisture = 8-10%.
- Road transport cost = AUD0.13/tkm = AUD1.25m p.a.
- Ocean freight = USD77/t[1)] = USD4.9m p.a.
- Power = grid-supplied (AUD0.10/kWh)
- Production = 64kt gold concentrate p.a.

Introduction of BALF

- 6” unit is estimated (CAPEX = USD1m installed)[2)].
- Concentrate moisture reduced from 9% to 2%.
- OPEX – electricity 10 kWh/t[3)] @ AUD0.10/kWh = AUD1/t (AUD64000 p.a.)
- OPEX – maintenance = AUD50000 p.a.[4)]
- OPEX - Road transport saving = AUD125k p.a.
- Ocean freight saving = USD490k p.a.
- Nett OPEX = AUD1.2m p.a. saving.
- Payback = ~1 years.

Notes:

- 1) Vendor quotation for containerised transport.
- 2) BALF CAPEX estimated at USD700k + domestic engineering/installation costs.
- 3) BALF electricity consumption doubled to 10 kWh/t for modelling purposes.
- 4) BALF maintenance based on a maintenance contract with Australasian representative.

- Operating iron ore mine.
- Product moisture = 13%
- Material handling issues, customer acceptance issues.
- Governmental production constraint for wet tonnes mined and shipped.
- Transport to vessel loading = USD7/WMT
- Ocean freight = USD7/WMT
- Various wet processing plant streams of 150 tph or 300 tph.
- Low profit margin of USD5/t.

Introduction of BALF

- 10” unit designed, CAPEX = USD2m installed (wear protection significantly added to CAPEX)
- Product moisture reduced from 13% to 6%.
- OPEX – electricity 2.5 kWh/t @ USD0.06/kWh = USD1/t =USD194k p.a.
- OPEX – FEL and operators = USD120k p.a.
- OPEX – maintenance = 5% of CAPEX = USD100k p.a.[4)]
- OPEX – Freight saving = USD1/WMT = USDm1.3 p.a.
- EBITDA boost from 7% extra tons = USD460k p.a.
- Nett OPEX = USD1.2m p.a. saving.
- Payback = ~1.5 years.

Case study on Western Australia gold project

- 1.5 g/t Au hosted in shear zones, 0.7 g/t cutoff grade.
- Tailings disposal into new storage facility.
- Project CAPEX AUD57m (AUD184/oz)
- Project OPEX AUD1084/oz
- Power demand 8.2MW (diesel power assumed)
- Tonnage treated = 750 kt p.a. – 1.2 Mt p.a. (90 tph – 143 tph)
- 5:1 stripping ratio
- CIL processing.
- **Project stalled as no tailings facility allowed.**

Introduction of BALF

- 150 tph BALF unit recommended (10” BALF unit)
- Drying of tailings from 20% moisture to 6% moisture (to avoid dust generation).
- Water captured from humid air in condenser.

- CAPEX AUD2.85m (Vulcantech estimate excluding extra materials handling)
- OPEX Electricity 5 kWh/t @ AUD0.30/kWh = AUD1.50/t
- OPEX maintenance = AUD100k p.a.
- OPEX TOTAL = AUD1084/oz + BALF AUD6.15/oz = AUD1090/oz.

- For an extra AUD6/oz the project can proceed based on co-disposal of fine material with waste.

Bergaz ex-works supply - Equipment list

- Roots blower(s) including silencers
- Pipeline to acceleration chamber
- BALF acceleration chamber
- Auger for material feed
- Defined length pipeline
- Pipeline sweeps
- Primary separation cyclone
- Vortex finder control
- Secondary cyclone if required
- Dropboxes if required

- Ceramic lining of pipelines and cyclones if required
- PLC control system (flexible on brand)
- PLC programming, installation and commissioning supervision.
- Study and engineering support

Customer supply

- Local engineering including integration
- Feed of material into Auger
- Removal of material from underneath cyclones.

Wear Items

- Auger faces
- Cyclone faces
- Pipeline sweeps/bends

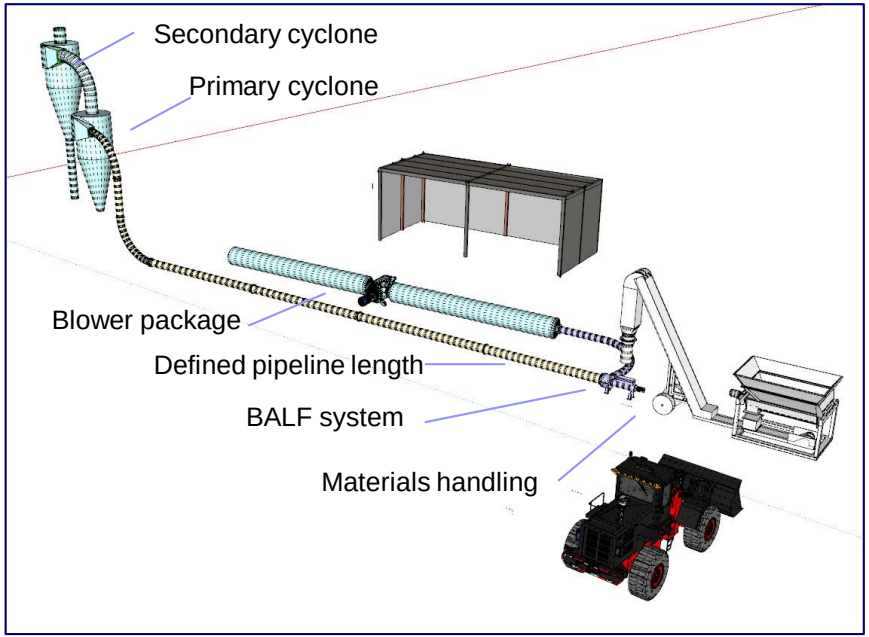
Provision made for

- Sealed bearings
- Easy maintenance access to auger
- Noise attenuation, electrical, structural design and supply according to client specification.
- Participation in client HAZOPs as required.

Bergaz (Salt Lake City)
- Perform test work
- Equipment design
- Equipment manufacture and supply
- Commissioning

WF Engineering (Salt Lake City)
- Detailed engineering design of Bergaz supply
- Equipment manufacture and supply
- Commissioning
- Complete backup to Bergaz incl. contractual

Vulcan Technologies (Cairns)
- Economic analysis, test work design and management, study management, commissioning.
- Innovative solutions for dry beneficiation after drying in the Bergaz system.



Example of a standalone system schematic – client insisted on very high noise attenuation.

For more information visit
http://www.nonthermaldrying.com/
http://wfengineering.com
http://vulcantech.com.au