Global Coal Preparation and Materials Handling Overview/Technology Development
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Market Scenario
Global Coal Industry Facts in Figures

- Global Production 8 Billion Tonnes Saleable Coal in 2013
- Estimated additional Discard and Overburden removed 22 Billion Tonnes = Total extracted ~30 Billion Tonnes PA
- Despite Environmental concerns, Coal output continues to increase, driven by the emerging economies power requirements.
- Coal output is now expected to peak at ~10 Billion TPA in 2020 and then ?
- Declining output is dependant of the development of other methods of large scale Electrical Power Generation, or the development of Carbon Capture and sequestration technology
Conclusions and issues arising

- The Coal industry is not going to go away anytime soon
- Output will continue to decline in the Western World, but this decline will be compensated by developing world increased production and consumption
- There are still more than 1 Billion people in the world without access to Electrical Power, (600 M in India alone!). These are the 1 Billion that are the worlds poorest. There will be another 1 Billion people on the planet by 2020.
- As Coal Technologists, our job is to produce more efficient ways of Mining, Processing and Burning Coal to minimise environmental effects, whilst keeping the lights on.
- As an example, export of high quality low ash steam Coal from RSA or Australia to India, to blend with extremely poor local Coal, can see major reductions in CO2 emissions per Kwh, by improving combustion efficiency.
Technology development in Coal Mine Materials Handling

- By far the most important recent development in Materials Handling is the use of In – Pit Crushing and Conveying, (IPCC), systems.
- This is the substitution of Trucks with Mobile and Semi-Mobile ROM/Overburden Reception and primary crushing systems.
- As a large Opencast mine develops, the number of trucks required to transport and maintain a fixed output of Overburden and Coal, increases, because the distance to be travelled increases as the mine grows.
- Beyond a certain distance it is more economic to install Mobile, or semi – mobile Reception and primary crushing systems, which move towards the mining process.
- The output from the IPCC station is connected to the permanent static Handling system, via extendable Mobile Conveying systems.
Large Opencast Mine Kalimantan
Feeder Selection

Apron Feeder

Belt Feeder
ABON Primary/Secondary Sizers
Out Of Pit Conveyors
Relocation Equipment

- Transport Crawlers
  - Mechanical drive units rated up to 3600 tonne capacity
  - Hydraulic drive units rated up to 1250 tonne capacity
  - Commercially available for lease or purchase
Relocation Equipment (cont)

- Self Propelled Modular Transporters (SPMT’s)
- Number of modules determines rated capacity
- Commercially available for lease or purchase
Waste Stacking Systems
Boom Spreaders
Materials Handling Overview. FL Smidth Products and capability
Global Coal Preparation General Technology Trends

- There are many minor variations in flow-sheet design in all major Coal Producing countries, however a general trend has developed in most places, with the possible exception of China.
  1) Large Capacity single unit equipment is preferred to simply plant design and reduce the number of moving parts, and avoid distribution error.
  2) The Dense Medium Process is generally used in preference to Jig technology on + 1.0 mm feed.
  3) Most new Plants are now removing the 1 or 2 mm raw feed before the Dense Medium Process.
  4) An interim Process step using either Spirals or Upward Current separators are used to process the 1 or 2 mm x 0.25 mm - 0.15mm fraction.
  5) Froth Flotation Feed is now generally 0.25mm or 0.15mm x 0, or to 0.045mm, rather than the original 0.5mm x 0 seen in plants pre 1990.
Regional Flow-sheet Variations - Australia

- Very Large DMC’s up to 1.5M Diameter on 75mm x 2mm feed
- Reflux Separators 2mm x 0.25, gradually replacing Spirals
- Large Homogenising ROM and Product Stockpiles
- Column Flotation 0.25mm x 0
- Resurgence in Mechanical Flotation slowly floating Coals, (NSW)
- Fine Clean Coal Thickeners used to concentrate Vacuum Filter feed, (Thin Froth from Jameson Cells or Column Cells).
- Large Diameter Disc Filters replacing HBF’s for Fine Coal dewatering
- Belt Presses or Solid Bowl Centrifuges for fine Discard dewatering
- Steel Tank Tailings Thickeners up to 60M diameter on legs
Reflux Separator – Ludowici
Regional Flowsheet Variations RSA / Southern Africa

- Larcodems De-Shale Primary DM step employed. (Waterburg)
- Split Feed DMC’s 50mm x 12.5mm and 12.5mm x 2 mm (optimise yield by employing smaller dia DMC’s on smaller Coal, because of medium/high levels of N.G.M.)
- Large Diameter DMC’s replacing Baths and Drums High S.G Primary separation, with Low S.G. secondary stage is often the configuration
- Spirals generally used on 2mm x 0.15mm
- Recessed Plate Filter Presses being used on Froth Concentrate
- Flotation often excluded, due to extremely poor floating Coal
- Fine Slimes discarded minus 45 microns, Derrick Stacksizer being tested.
- Belt Filter Presses, or Recessed Plate Filter Presses used for fine tailings, where water is an issue
- Chinese 3 – Product Cyclone Technology being installed
SA CPP – Single Module, No Piping View
Regional Flowsheet Variations, USA/Canada

- USA/Canada
  - Daniels Baths 150mm x 12.5mm and DMC’s 12.5mm x 1 mm most common coarse circuit. Jigs in decline.
  - Spirals / Water – Only Cyclones and Reflux Classifiers used for 1mm x 0.25mm
  - Mechanical Flotation Used on 0.5mm x 0 and Column Flotation (Eriez Stack Cell) used on 0.25mm x 0
  - De-sliming at 0.045 mm common, prior to Flotation, for high ash slimes removal, ( Derrick Stacksizer, or Cyclones)
  - Fine Clean - Coal dewatering by Screen Bowl Centrifuge
  - Centribaric Centrifuges sometimes used to recover very fine Coal from SBC effluent
  - Belt Presses and Recessed Plate Presses used for Fine Tailings De – watering, ( sometimes in conjunction with Deep Cone Thickening.)
Regional Flowsheet Variations INDIA

- 600 M TPA Production but only 130 M TPA washed
- For PSF Dry De-Shaling being Proposed
- Jig Plants also under construction for PSF, some with Middlings DMC re-wash
- DM Plants with Spirals and Flotation also used
- For Coking Coal Plants Coal is generally crushed to minus 12.5mm top size to liberate coking properties
- Highest NGM in the World to produce Coking Coal, ~ +90% at 1.4 S.G. separation, to produce 18% Ash product
- Smaller Diameter DMC’s up to 660mm used, because of NGM on 12.5mm x 0.5mm. High S.G. separation first in 3 product plant is the normal configuration
- Mechanical Flotation used from 0.5mm x 0
- Froth Dewatering by Vacuum Filtration
- Tailings Dewatering by Recessed Plate Filter Presses.
- Discard and Fine Tailings sold as Domestic fuel
Regional Flowsheet Variations CHINA

- Large Centralised Plants replacing hundred’s of smaller plants
- 3 – Product DM Cyclones often seen on 100mm x 0 mm feed, in addition to more conventional Bath/DMC Plants
- No De-sliming ahead of 3 – Product Cyclone Plants
- Fines minus 0.5mm often re washed in Fine Coal DMC’s
- Flotation also used on fines, both Column and Mechanical
- Screen Bowl Centrifuges used to Dewater Fine Clean Coal
- Recessed Plate Filter Presses also used to Dewater both Fine Clean Coal and Tailings
- Hyperbaric Disc Filters also used for fine Coal due to very high fines content in ROM feed causing excessive product moistures
- Dry Cleaning systems used in arid areas.
Regional Flowsheet variation’s Europe/Russia

- DM Bath, or Drums on 100mm x 12.5mm
- DMC’s on 12.5mm x 1mm
- Spirals on 1mm x 0.15mm
- Flotation on 0.15mm x 0
- Fine Clean Coal Dewatered using either Screen Bowl Centrifuge, Recessed Plate Filter Presses or Andritz Hyperbaric Filters
- Due to extreme cold conditions in winter, moisture limits on Coal Products are critical.
- All Plants have closed water circuits, usually using Belt Filter Presses, as make – up water is frozen
- Thickeners are limited in Diameter to 25M in order to be located in the heated washery buildings
Fine Coal Separation Technology 2mm x 0.15mm

- Most New plants now process the 1mm or 2mm x 0.25 or 0.15mm fraction using Gravity Based technologies.
- If a Steam Coal is the product and a high S.G. of separation is acceptable, Spiral separators are the usual choice.
- If a Higher Quality, Low Ash Product is required, the Spiral has a problem in that it’s SG of separation is fairly rigid around 1.70 – 1.85.
- This means that if you wish to include the Spiral Concentrate in a Low ash product an even lower ash DMC product is required to compensate for the High SG, and ash Spiral Floats. This can lead to significant loss of yield of Low ash High value product.
- There are two methods to process the intermediate fraction, at lower SG cut points, to maximise yield:
  1) Fine Coal Dense Medium Cyclones
  2) The Reflux Classifier
Fine Coal Dense Medium Cyclones

- Technology originally introduced in 1957 by DSM
- A resurgence occurred in the 1980’s to produce export coking Coal in RSA
- New Interest in RSA and Australia for low gravity separations to increase yield of low ash products.
- In China the 3 Product DM Cyclone plants, which do not include a de-slime step, use a fine Coal DM Cyclone to recover fine coal from the medium circulation system. This system, although widely used in China, is inflexible and has a high magnetite consumption.
Reflux Classifier How it works

A REFLUX™ Classifier (RC™) is a combination of a:

- Lamella Settler
- Autogenous dense medium Separator
- Fluidised Bed Separator

A REFLUX™ Classifier is a volumetric unit.
The operation draws together the best elements of these different systems

- A powerful density based separation develops within the inclined channels. This forces low density particles to overflow, and but retains high density particles

- Fine high density particles form a autogenous dense medium (above the fluidised bed) This zone then sends larger low density particles towards the inclined channels, and then to overflow
**Fine Clean Coal Dewatering 1mm x0**

- Horizontal Belt Vacuum Filters and Screen Bowl Centrifuges are most commonly used methods.
- For extreme cases such as Siberia, where temperatures can be –50°C, more extensive methods such as Hyperbaric Disc Filters, or Recessed Plate Filter Presses are used, to avoid the fines product freezing in the transport rail wagons.
- Thermal Dryers are being closed because of costs of operation and environmental concerns.
- New methods including Microwave drying techniques are being considered.
Tailings Treatment and Disposal

- Five Methods are commonly used:
  
  1) Disposal to a lagoon
  2) Disposal to a reduced size lagoon with advanced Flocculant technology
  3) Dewatering by Recessed Plate Filter Press
  4) Dewatering by Belt Filter Press
  5) Dewatering by Solid Bowl Centrifuge
  6) Dewatering by Deep Cone Thickener and blending/co-disposal with coarser solids, (Crushed)
Pressure Filters
Thickeners

Deep Cone Paste Thickeners
Deep Cone Thickening and Co – Disposal with Larger Discard – History 1970’s and 1980’s

NCB STANDARD
DEEP CONE THICKENER

Control Circuit Single Cone
KEY
1. Feed Flow Meter
2. Liquid Density Meter
3. Multiplier
4. Ratio Station
5. Flocculant Controller
6. Flocculant Metering Pump
7. Feed Control Valve
8. Feed Controller
9. Discharge Controller
10. Discharge Valve
SA CPP - 3 Modules x 800 tph