BAUXITE RESIDUE VALORISATION AND BEST PRACTICES CONFERENCE

Leuven 5-7 October 2015
Process Options for the Filtration and Washing of Bauxite Residue

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Reinhard Bott
Bauxite Residue Treatment is a Big Challenge

**Alumina Refinery - Schematic Flowsheet**

- **Man Power**
- **60 - 250 kg Na₂O**
- **14 - 40 GJ Thermal Energy**
- **M+C Process Control**
- **4 - 5 Mio. tpa Bauxite**
- **Bayer Process**
- **2 Mio tpa Al₂O₃**
- **1 Mio. tpa Aluminium**
- **1 - 2 Mio. tpa Red Mud (dry solids)**

**Investment depends on solution for „Zero Discharge“**

**How to master this huge unwanted residue?**
Thickened or Filtered: Disposal of Red Mud Is a Major Problem ...

... due to:

- high amounts
- terrible material handling
- soda contamination
- high transportation costs
- disposal site with
  - high space demand
  - high maintenance costs
  - environmental impact
  - high recultivation costs
Sustainability Is a Major Challenge Facing the Minerals Industry

Closing the Loop  Zero Waste  DBR Dry Bauxite Residue

Ca.120 Mio tpa dry solids of bauxite residue

Tonnage per refinery:
- e.g. 2 Mio tpa alumina
- 1 – 2 Mio tpa red mud (dry solids)

Re-Usage
Currently Promising Possibilities for Industrial Re-Usage

<table>
<thead>
<tr>
<th>Additive for cement production / iron ore production</th>
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<tbody>
<tr>
<td>▪ Addition to cement kilns both for its iron content (instead of original, costly bauxite) and its capability to reduce scale on the kiln</td>
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<td>▪ Sintering aid for iron ore pellets at steel production</td>
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<th>Soil improvement</th>
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<tr>
<td>▪ Dry bauxite residue improves phosphorous retention and increases crop yield</td>
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<tr>
<td>▪ Fixing agent for heavy metals and metalloids for heavy metal contaminated soils</td>
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<tr>
<td>▪ <em>Fertilizer for poor and/or acidic soils as well as for horticulture</em></td>
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<th>Land reclamation</th>
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<tr>
<td>▪ Use for land reclamation (e.g. for garbage dumps, ground sealing &amp; covering)</td>
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<th>Metal recovery</th>
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<td>▪ extraction of metals: source for Fe, Ti, Sc, Ga, …..</td>
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<th>Further possibilities of re-usage</th>
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<tr>
<td>▪ street and dam building</td>
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<tr>
<td>▪ material for bricks and tiles</td>
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Decisive Requirements for Industrial Re-Usage

- clean product
  - proper composition
  - low soda content $\leq 3 \text{ g NaOH} / \text{ kg DS}$
    - intensive washing required

- secure and problem free handling
  - not sticky
  - not thixotropic
  - dry product with bulky, sand-like behaviour
  - low moisture content $mc \leq 28\%$
    - below thixotropic point and flow moisture point
Dewatering and Disposal Methods for Red Mud

- **Moisture Content: MC = 48 – 55 wt%**
  - Deep cone thickeners
  - Drum filters with roller discharge
  - Very big filter presses
    - MC = 35 – 50 wt%
  - HiBar Pressure & Steam Pressure Filtration
    - MC = 30 – 32 wt%

- **Moisture Content: MC < 28 wt%**
  - Low caustic & not thixotropic
  - Industrial re-usage
  - Dry disposal

Disposal Methods:
- Pond (wet) disposal
- Dry stacking
- Industrial re-usage
- Dry disposal
Dewatering and Disposal Methods for Red Mud

Deep cone thickeners: old fashioned

Drum filters: old fashioned

Filter presses:
- low moisture
- poor washing
- lumpy and solid cake
- lower soda

HiBar Pressure & Steam Pressure Filtration:
- low moisture
- excellent washing i.e. low caustic cake
- dry product with bulky, sand-like behaviour
- Very low soda
What is HiBar Filtration?
Continuous Pressure Filtration & Steam Pressure Filtration

- Compressor
- Superheated steam
- Steam cabins
- Disc filter (drum or pan filter)
- Filtrate receiver
- Cake blow off tank
- Discharge sluice
- Slurry pump
- Filtrate
- Filter cake

Optional: Steam Pressure Filtration
HiBar Filtration Processes

- continuous operation & high throughput rates
- rotary drum, disc or pan filters inside a pressure vessel
- high filtration pressure difference of up to $\Delta p = 6$ bar
- high vessel pressure of up to 15 bar, abs
- high process temperature of up to 200°C
- discharge of cake from filter cloth by air-blow-back
- reliable sluice technology for discharging the filter cake out of the vessel

Standard version of Hi-Bar Filtration:

- compressed air is used for the filtration process

HiBar Steam Pressure Filtration:

- superheated steam is used for cake dewatering and cake washing
Why Steam Pressure Filtration?
Very Low Residual Moisture Converting Red Mud to Dry Bauxite Residue

Model of the Condensate Front:

- continuous moving of an even condensate front
- homogeneous heating of the filter cake
- emptying of nearly all pores
- viscosity reduction of the residual liquid leading to:
  - excellent cake washing out
  - extremely low moisture content

Filter cake:
- before
- during
- after steaming

Dewatering time $t_2$

Filter cloth

cold and saturated

hot and dry

Condensate Front:

- wet & sticky cake $mc = 35\%$
- dry cake $mc = 23\%$

Vacuum filtration

Steam Pressure Filtration

Why Steam Pressure Filtration?

Very Low Residual Moisture Converting Red Mud to Dry Bauxite Residue

Filter cloth

Filter cake:
- hot and dry

Dewatering time $t_2$
Hi-Bar Disc Filter (70 m²) for Steam Pressure Filtration

First HiBar Steam Pressure Filtration Plant for Dry Bauxite Residue (DBR)

- steam cabins
- segments
- Cake discharge

Filter shaft

Control head
First HiBar Steam Pressure Filtration Plant for Dry Bauxite Residue (DBR)

Filter building - 2 x HiBar Disc Filter (70m²)

Man hole
Target of Client:

**moisture ≤ 28 wt%** to go below thixotropic point for:

- DBR handling
- DBR disposal with steeper dumping slopes

- improved safety of the disposal site – no damps needed

- 2 x HiBar disc filter 70 m² per filter with 5 discs/filter
  - 1 filter in operation,
  - 1 filter as stand-by

- red mud with very small particle size of: \( x_{50} = 1.9 \mu m \)

- filtration pressure difference
  \( \Delta p = 4 - 6 \text{ bar} \)

- Solids throughput: 32 t/h

- moisture content \( mc \) in wt%
  - pressure filtration: ≤ 28 wt%
  - SPF: ≤ 25 wt%
Filter in Operation – Cake Discharge (h_C = 9.5 mm)
Dry Filter Cake – Conveyor Discharge of a Flowable Bulk
Operational Results During Commissioning

- Moisture content:
  - $mc \leq 28$ wt% with operation in pressure filtration mode during commissioning
  - $mc \leq 25$ wt% with steam pressure filtration for hot operation later

- Solids throughput: 32 t/h targeted
- Filter speed: 0.3 rpm (up to 1.2 rpm)
- Cake height: 9.5 mm
- Pressure difference: $\Delta p = 4 - 6$ bar
Outlook & Vision

Direct filtration of hot bauxite residue slurry after digestion

ground bauxite

\[ \text{digestion} \quad p = 4 - 5 \text{ bar} \]
\[ T = 140 - 150 \degree C \]
\[ c_S = 50 - 70 \text{ g/l} \]

ca. 2 % extractable alumina (gibbsite) stay undigested

\[ \text{flash tank} \quad T \approx 100 - 105 \degree C \]
\[ p = 1 \text{ bar} \]

cooking down / long residence time

direct filtration by Hi-Bar Filtration
- no cooling down
- short residence time

pregnant liquor with
\[ T \approx 145 \degree C \]
\[ p \approx 4 \text{ bar} \]

4 - 5 % loss of extractable alumina (gibbsite) in settlers and red mud washers

ca. 2 % loss of extractable alumina (gibbsite) in the settlers

ca. 2 % loss of extractable alumina (gibbsite) during red mud washing

4 - 5 % loss of extractable alumina (gibbsite) in settlers and red mud washers

red mud washing

red mud washing

red mud washing

red mud dewatering/disposal
Many Thanks
for Your Attention

Clever Filtration

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