The advancement and developing of red mud utilization in China

Dr. Wanchao Liu

Zhengzhou Research Institute of CHALCO

For ICSOBA 2013, Krasnoyarsk
1 Alumina production and Red mud

Alumina production growth in China and the world in the past ten years
1 Alumina production and Red mud

◆ Globally:

In 2012, the total production of red mud: more than 100 million tons,
the cumulative amount: more than 3 billion tons;

◆ In China:

In 2012, the total production of red mud: over 40 million tons,
the cumulative amount: more than 250 million tons.
1 Alumina production and Red mud

- Red mud from sintering/combined process
  - Red mud
    - Bayer red mud
      - Low iron red mud
        - Low temperature Bayer red mud
      - High iron red mud
        - High temperature Bayer red mud

Category of red mud
# 1 Alumina production and Red mud

## Chemical composition of representative red mud samples (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gibbsite</td>
<td>high iron</td>
<td>low iron</td>
<td>high iron</td>
</tr>
<tr>
<td><strong>Na₂O</strong></td>
<td>11.34</td>
<td>11.60</td>
<td>5.55</td>
<td>2.80</td>
</tr>
<tr>
<td><strong>MgO</strong></td>
<td>0.48</td>
<td>1.20</td>
<td>1.09</td>
<td>1.70</td>
</tr>
<tr>
<td><strong>Al₂O₃</strong></td>
<td>19.95</td>
<td>16.82</td>
<td>23.97</td>
<td>6.40</td>
</tr>
<tr>
<td><strong>SiO₂</strong></td>
<td>23.71</td>
<td>16.66</td>
<td>17.21</td>
<td>22.00</td>
</tr>
<tr>
<td><strong>K₂O</strong></td>
<td>0.21</td>
<td>---</td>
<td>0.39</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>CaO</strong></td>
<td>2.73</td>
<td>8.86</td>
<td>20.83</td>
<td>41.90</td>
</tr>
<tr>
<td><strong>TiO₂</strong></td>
<td>1.51</td>
<td>4.17</td>
<td>5.96</td>
<td>3.20</td>
</tr>
<tr>
<td><strong>Fe₂O₃</strong></td>
<td>32.04</td>
<td>37.48</td>
<td>10.39</td>
<td>9.02</td>
</tr>
<tr>
<td><strong>LOI</strong></td>
<td>11.40</td>
<td>9.05</td>
<td>7.12</td>
<td>11.70</td>
</tr>
</tbody>
</table>
1 Alumina production and Red mud

Proportion of 4 kinds of red mud in China

- High iron Bayer red mud from diaspor, 18%
- High iron Bayer red mud from gibbsite, 26%
- Low iron Bayer red mud from diaspor, 49%
- Red mud from sintering and combined process, 7%
## 2 Red mud utilization in China

### Main utilization directions

<table>
<thead>
<tr>
<th>No.</th>
<th>Red mud</th>
<th>Direction</th>
<th>Volume</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>sintering /combined process</td>
<td>Building and construction materials</td>
<td>200-250 kt/a</td>
<td>Use red mud directly</td>
</tr>
<tr>
<td>2</td>
<td>High iron red mud from gibbsite and diaspore</td>
<td>Building materials (bricks)</td>
<td>1000-1300 kt/a</td>
<td>use the sand separated from red mud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cement</td>
<td>800-1000 kt/a</td>
<td>iron ore separated from red mud</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Iron &amp; Steel Production</td>
<td>800-1000 kt/a</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Bayer red mud from China local diaspore</td>
<td>Glass ceramics, glass fibre...</td>
<td>100 kt/a</td>
<td>It will run in the end of 2013.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Rare Earth Elements recovery (REE)</td>
<td>/</td>
<td>In research</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Polymer filler</td>
<td>10 kt/a</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>All red mud</td>
<td>Environmental protection (exhaust gas and waste water adsorbent)</td>
<td>10kt</td>
<td>In pilot research</td>
</tr>
<tr>
<td></td>
<td>totally</td>
<td></td>
<td>3000 - 3600 kt/a</td>
<td></td>
</tr>
</tbody>
</table>
3 Utilization

Red mud from sintering and combined process

Building Materials

- Larnite is the domestic in the red mud, which is comment contributor to construction.
- Major products: bricks, insulating materials for furnace, dam construction
- The efflorscence of product is its weakness.

heat insulating material
Non-fired bricks
3 Utilization
—— Red mud from sintering and combined process

☐ Construction Materials

✓ Road base material
✓ Dam Construction

The road built with red mud base

The red mud dam constructed with red mud, use for storing Bayer red mud
3 Utilization
—— High iron red mud from gibbsite and diaspore

- Separating iron and degritting
### 3 Utilization

--- High iron red mud from gibbsite and diaspore

#### Separating iron and degritting

<table>
<thead>
<tr>
<th>Bayer red mud</th>
<th>Iron</th>
<th>Sand</th>
<th>Fine red mud</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield, kg/t red mud</td>
<td>Fe$_2$O$_3$, wt%</td>
<td>Yield, kg/t red mud</td>
</tr>
<tr>
<td>Diaspor high temperature Bayer process</td>
<td>60-80</td>
<td>52-57</td>
<td>30-50</td>
</tr>
<tr>
<td>Gibbsite, low temperature Bayer process</td>
<td>80-130</td>
<td>52-57</td>
<td>100-120</td>
</tr>
</tbody>
</table>

Almost all of high iron red mud (15-18 million tons) are treated in this process in China.
3 Utilization

—— High iron red mud from gibbsite and diaspore

Production Site
3 Utilization
—— Low iron red mud from China diaspore

☐ Glass-ceramic

Application: wall and floor tile, Wear-resisting lining
Status: In construction

Advantage: low melting points, large market

Sample of glass-ceramic
The glass ceramic sintering kiln
3 Utilization

—— Low iron red mud from China diaspore

☐ Rare Earth Elements (REE) Extraction

The feasibility of the process depends on the contents of REE in red mud.
3 Utilization

—— Low iron red mud from China diaspore

☐ Rare Earth Elements (REE) Extraction

✓ Present acid leaching - extraction process is defective.
✓ The environmental and economical extraction process is significant and challengeable.
3 Utilization —— red mud

- Mineral fillers (from red mud or separated red mud)

Application in: plastics, rubber, wood plastic products (substitute of Precipitated Calcium Carbonate (PCC), and white carbon black).

Developing direction: superfine filler, low iron filler

Expected profit: 100-200 RMB/t red mud

Fresh red mud (hydrophilic)  Modified red mud (oleophytic)  PVC electrical conduit pipe from red mud  PVC threading pipe and drain-pipe from red mud
3 Utilization — red mud

- Absorbent for gas desulfurization
  - The pilot test was completed.
  - Its de-sulfuring efficiency is satisfying.
  - However, the mud is adhesive on the surface of desulfurization facilities, because of its higher density and cementitious property.
  - The application in waste water treatment is in research both in China and oversea.
4 Conclusions & Discussion

Future:

- **High iron red mud**
  
  Magnetic separation technology should be improved for fine weak-magnetic material separation from mud slurry;
  
  High efficient iron extracting and iron separation technology after magnetization roasting;
  
  Utilization of the red mud after iron separation.
4 Conclusions & Discussion

- Low iron red mud (About 50% of the total of red mud)

Environmental REE extracting technology;
Some other methods to consume red mud in large-scale.
Feasible soda removal processes.
Almost 50% of research papers on red mud are from China. Others from India, Australia and Greece....

In China, more attention is focused on industrialization. And some technologies are or in commercial application. This is ahead of the world.

So, the research center on red mud is in China.

However, cooperation is absolutely important for the common global problem.
Thank you!

Wanchao Liu
Zyy_lwc@chalco.cn

2013.9