Outlook for the Chinese Alumina Industry

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Main Contents

- Review of Aluminum Smelting Industry in China
- Review of Bauxite and Alumina Industry in China
- Solutions to sustainable development of Chinese Alumina Industry
Part I

Review of Aluminum Smelting Industry in China
The average growth rate of primary aluminium production from 2002 to 2012 is 18%, Output was 21.85 Mt in 2012 and it will be 24.0 Mt in 2013. The total capacity will be 32.0 million tons by the end of 2013.
New Capacity of Primary Al Concentrated in the Western Provinces

The Proportion of Primary Al Produced in the Western to the Total in China
According to the investigation of CNIA, 71% of new capacity was put into production in the western provinces in 2012, 84% of new capacity in 2013 will be in the western provinces.
Part Ⅱ

Review of Bauxite and Alumina Industry in China
The average growth rate of alumina output from 2006 to 2012 is 22.4%. Output was 42.17 Mt in 2012 and it will be about 43.5 Mt in 2013.
The bauxite reserve is 28 billion tons in the world.

If the annual global consumption is about 250 Mt, the world’s bauxite supply could be maintained for more than 100 years.
Bauxite Resource in China

- Bauxite reserve is 0.83 billion tons in China.
- It is only about 2.9% of that in the world.
- The total alumina capacity was 57.19 million tons, the operating rate is about 77% in 2012.
- The total capacity will be more than 60 million tons by the end of 2013.
- Given that annual output of alumina produced from domestic bauxite is 20 million tons, it is generally believed that bauxite reserve in China could be used only for 15-20 years.
## Imported Bauxite and Alumina

The imported bauxite and alumina amount in recent years (Mt)

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite</td>
<td>2.17</td>
<td>9.68</td>
<td>23.26</td>
<td>25.29</td>
<td>19.69</td>
<td>30.07</td>
<td>45.00</td>
<td>39.61</td>
</tr>
<tr>
<td>Alumina</td>
<td>7.02</td>
<td>6.91</td>
<td>5.12</td>
<td>4.59</td>
<td>5.14</td>
<td>4.31</td>
<td>1.88</td>
<td>5.02</td>
</tr>
</tbody>
</table>
### Bauxite Grade Downward Continuously in China

#### Bauxite A/S in some Typical Refineries

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.50</td>
<td>6.85</td>
<td>6.07</td>
<td>5.52</td>
<td>5.02</td>
<td>4.5~5.0</td>
</tr>
<tr>
<td>B</td>
<td>6.30</td>
<td>5.88</td>
<td>5.05</td>
<td>5.14</td>
<td>4.81</td>
<td>4.5</td>
</tr>
<tr>
<td>C</td>
<td>13.17</td>
<td>12.10</td>
<td>12.07</td>
<td>14.08</td>
<td>12.34</td>
<td>~10</td>
</tr>
<tr>
<td>D</td>
<td>9.90</td>
<td>10.21</td>
<td>9.15</td>
<td>7.61</td>
<td>6.40</td>
<td>4.5~5.0</td>
</tr>
</tbody>
</table>
Part Ⅲ

Solutions to sustainable development of Chinese alumina industry
Domestic bauxite reserve is not enough to meet alumina capacity and output increasing dramatically.

Bauxite grade has gone downward, the bauxite, soda and energy consumption in alumina production process goes up continuously.

The disordered expansion of alumina capacity must be restrained effectively.

China has to increase available bauxite amount as possible.
Efforts have been made to meet the challenges from China alumina industry:

- to effectively refrain rocketing rise of domestic alumina capacity
- to develop the effective alumina production process from low grade bauxite and high sulfur bauxite
- to reinforce the bauxite exploration in China
- to seek alternative resources
- to use as much oversea bauxite as possible
- to intensify the research on the utilization of bauxite residue
- to pay more attention to the Ga recovery from alumina production process
- ....
“Aluminum Industry Specifications” has been put into effect since July 18, 2013.

- To speed up the regulation and restructuring of aluminum industry.
- To restrain the disordered expansion of aluminum and alumina capacity.
- To promote sustainable harmonious development and energy saving and emission reduction.
“Aluminum Industry Specifications”

- Production scale and major external requirements
  - At least capacity 0.8mt/y is required
  - The service life of owned mine: >30 years; if using imported bauxite, long-term reliable external resource is necessary
  - For the project taking use of fly ash, capacity: >0.5mt/y, the site of the project has to be adjacent to the origin of fly ash, fly ash resource should be available for at least 30 years
“Aluminum Industry Specifications”

- Technology and Equipments
  - high efficiency and advanced process
  - low energy consumption and emission
  - such as Bayer process and Series Combination processes
“Aluminum Industry Specifications”

- **Comprehensive Energy Consumption**
  - **Bauxite Mining:**
    - in the underground mining $< 25$Kg.ce/t-bauxite, in the open mining $< 13$Kg.ce/t-bauxite
  - **Newly built alumina refinery:**
    - $< 480$Kg ce/t-alumina in Bayer process, $< 750$Kg ce/t-alumina in other process
  - **Existing alumina refinery**
    - $< 500$Kg ce/t-alumina in Bayer process, $< 800$Kg ce/t-alumina in other process
Consumption and Comprehensive Utilization of Bauxite Resources

- in the newly built Bayer alumina line:
  if the bauxite A/S >7, alumina recovery: >81%, water consumption < 3t/t-alumina, covering area < 0.5 m²/t-alumina

- in the newly built non-Bayer alumina line:
  alumina recovery: >90%, water consumption < 7t/t-alumina, covering area < 1.2 m²/t-alumina

- In Existing alumina refinery
  if the bauxite A/S >5.5, alumina recovery: >75%
New process for low grade bauxite
- Flotation Bayer process
- Improved series combination process

New process for high sulfur bauxite
- Flotation desulfurization and Bayer process
- Calcining desulfurization and Bayer process
Bauxite exploration in China

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Mine Lots</th>
<th>Reserve Base</th>
<th>Resources</th>
<th>Identified Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>410</td>
<td>735.14</td>
<td>2296.22</td>
<td>3031.36</td>
</tr>
<tr>
<td>2009</td>
<td>432</td>
<td>839.23</td>
<td>2363.38</td>
<td>3202.61</td>
</tr>
<tr>
<td>2011</td>
<td>464</td>
<td>1050.64</td>
<td>2822.50</td>
<td>3873.14</td>
</tr>
<tr>
<td>2012</td>
<td>465</td>
<td>905.90</td>
<td>2912.90</td>
<td>3818.80</td>
</tr>
</tbody>
</table>

Accumulative bauxite has been found in Henan firstly in 2013. Increased resources is about 161 million tons.
Fly ash produced as high as 400 million tons every year in power industry of China.

More and more research works have been carried out.
- Soda lime sintering process
- Lime stone sintering process
- Acid process
- Alkali and acid combination process
- Ammonium aluminum sulfate process
Chinese enterprises investment in bauxite and alumina projects overseas

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>Guinea</td>
<td>$6 billion investments to develop 1.2 Mt/a bauxite, 0.4 Mt/a refineries and 270 MW coal-fired power station</td>
</tr>
<tr>
<td>Henan International</td>
<td>Guinea</td>
<td>558 km² bauxite mining right</td>
</tr>
<tr>
<td>Bosai</td>
<td>Guyana</td>
<td>$1.5 billion investments to develop 1.2 Mt/a bauxite and 0.4 Mt/a refineries, Oumai 70% stake in mining company</td>
</tr>
<tr>
<td>Bosai</td>
<td>Ghana</td>
<td>1.2 billion investments to develop refinery in Ghana, 80% stake in Ghana Bauxite Company</td>
</tr>
<tr>
<td>Pioneer (Beijing) Investment Fund</td>
<td>Philippines</td>
<td>250 million tons bauxite</td>
</tr>
<tr>
<td>Xinfa</td>
<td>Fiji</td>
<td>Aurum wholly owned Fiji Development Co., Ltd.</td>
</tr>
<tr>
<td>Xinfa</td>
<td>Australia</td>
<td>7 Mt/a bauxite capacity, Five-year 1 Mt/a off-take agreement, Australian Cape Alumina Limited shares 17.5% stake</td>
</tr>
</tbody>
</table>
## Chinese enterprises investment in bauxite and alumina projects overseas

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<thead>
<tr>
<th>Company</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Xinfa</td>
<td>Indonesia</td>
<td></td>
</tr>
<tr>
<td>Chalco</td>
<td>Indonesia</td>
<td>refineries</td>
</tr>
<tr>
<td>Jinjiang</td>
<td>Indonesia</td>
<td>Indonesian Kalimantan Island to build a refinery</td>
</tr>
<tr>
<td>Weiqiao</td>
<td>Indonesia</td>
<td>Plans to build 1 Mt of refinery</td>
</tr>
<tr>
<td>Nanshan</td>
<td>Indonesia</td>
<td>2.1 Mt/a alumina capacity</td>
</tr>
<tr>
<td>Nanshan</td>
<td>Australia</td>
<td>Australian Gulf Aluminum Company Shares 20% stake</td>
</tr>
<tr>
<td>Yankuang</td>
<td>Australia</td>
<td>3.5 Mt/a bauxite and 1.1 Mt/a alumina capacity, stake in BRL.</td>
</tr>
<tr>
<td>Yunnan Aluminium Co. Ltd</td>
<td>Laos</td>
<td>Plans to build 1 Mt of refinery</td>
</tr>
<tr>
<td>Minmetal</td>
<td>Jamaica</td>
<td>Joint venture of 1.5 Mt/a refining capacity with 150 Mt mining license</td>
</tr>
</tbody>
</table>
Chinese enterprises investment in bauxite and alumina projects overseas

- The Large Bauxite Acquisition in the Philippines by Pioneer (Beijing) Investment Fund
- Gibbsite bauxite, approximately 250 million tons, with an average grade of alumina 43%, A/S 12
- It can provide 10 million tons of high quality bauxite annually to China in the future
The dry stockpiling technology of the bauxite residue is being applied in more and more alumina refineries.
The research on ecological remediation of the red mud yard.
The utilization efficiency is about 4~5% now

- Red mud used to road constructing
- Iron ore (Fe2O3% > 55%)
- Cement bricks made from red mud
Ga Recovery from the Alumina Production Process

- More than 10 refineries recover Ga from the alumina production process in China.
- Ga capacity is about 330t/y by the end of 2012. The output was about 270t in 2012.
- The output will be about 300t in 2013.
Welcome to China for ICSOBA 2014

- **32nd CONFERENCE and EXHIBITION ICSOBA**

- **Organizer**
  The International Committee for Study of Bauxite, Alumina & Aluminum (ICSOBA)
  Aluminum Corporation of China (CHINALCO)

- **Host**
  Zhengzhou Research Institute of CHALCO

- **Date**
  12-16 October, 2014
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Thanks for your Attention!