China’s Bauxite and Alumina Industry

Dr. Li Wangxing,
Dr. Yin Zhonglin,

Zhengzhou Research Institute of CHALCO

26 October 2011
Brief Introduction of Author

- **Dr. Li Wangxing, Professor**
  Chief Engineer of CHINALCO
  President of R&D Center of CHALCO
  CEO of China National Engineering & Technology Centre for Aluminium
  President of Zhengzhou Research Institute, CHALCO
  President of Alumina Technical Committee in China

- **Dr. Yin Zhonglin, Professor**
  Director of Alumina Research Division, Zhengzhou Research Institute, CHALCO
  Secretary General of Alumina Technical Committee in China
Outline

- Analysis of Bauxite Availability in China
- Progress of Alumina Technology in China
- Prospect of Chinese Alumina Industry
Part I

Analysis of Bauxite Availability in China
The average growth rate of primary aluminium production from 2000 to 2010 is 19%. Output was 16.2 Mt in 2010 and would be about 19.5 Mt in 2011.
The average growth rate of alumina output from 2006 to 2010 is 23%. Output was 28.95 Mt in 2010 and would be about 37 Mt in 2011.
The number of alumina refineries was 34 in 2010, in which there are 12 refineries with capacity more than 2 Mt.

The constructed capacity is about 43 million tons in 2011.

There are 6 newly constructing refineries in 2011 with the total capacity of 8.9 million tons.
Bauxite supply is abundantly available worldwide. Based on the amounts of the reserve above, and the annual global consumption of around 200 Mt, the world’s bauxite supply could be maintained for more than 100 years.
Bauxite Resource in China

- Shortage of Reserve

- In China, bauxite reserve is 0.7 billion tons, and basic reserve is 2.3 billion tons.

- 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 for 20-25 years.
Imported Bauxite and Alumina

The imported bauxite and alumina amount in recent years

<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>2011.1-7</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>24.47</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>1.07</td>
</tr>
</tbody>
</table>

The alumina capacity from imported bauxite is 14.4 Mt, and the output is 10.5 Mt in 2010.
The price of imported bauxite is always obviously higher than that of the domestic bauxite.

The production cost using overseas bauxite is higher than that using domestic bauxite at present.

Importing bauxite will be insignificant in case that the price of imported bauxite becomes higher or the alumina price becomes lower to a certain degree.
Part II

Progress of Alumina Technology in China
Characteristics of Bauxite Resource in China

- Most of bauxite in China is diaspore with high alumina, high silica content and complex minerals, which leads to coexistence of Bayer process, Sintering process and Combined process to treat bauxite efficiently.
Alumina Production Process for Diasporic Bauxite in China

- Low A/S
  - Sintering: \( \sim 35 \text{ GJ/t-AO} \)
  - Combined process: \( \sim 25 \text{ GJ/t-AO} \)
  - Flotation Process: \( \sim 15 \text{ GJ/t-AO} \)

- Middle & High A/S
  - Bayer Process: \( \sim 10 \text{ GJ/t-AO} \)
The series of flotation desilication pilot tests of bauxite with A/S 3-5 were completed by ZRI of Chalco.

In 2004, a production line using Flotation was put into operation. Flotation-Bayer process is more competitive in treating low grade bauxite.

It is extensively used now in middle China.

### Industrial Test Results of Flotation Desilication

<table>
<thead>
<tr>
<th>Product</th>
<th>Content %</th>
<th>A/S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al₂O₃</td>
<td>SiO₂</td>
</tr>
<tr>
<td>Tailing</td>
<td>39.03</td>
<td>31.16</td>
</tr>
<tr>
<td>Concentrate</td>
<td>65.87</td>
<td>6.58</td>
</tr>
<tr>
<td>Ore</td>
<td>56.79</td>
<td>14.90</td>
</tr>
</tbody>
</table>
Shandong Branch used overseas bauxite firstly in China.

The first production line based on low temperature Bayer process using imported gibbsite was put into production in 1993.

There are at least 5 refineries using imported gibbsite in China.
Chinese diasporic bauxite requires high digestion temperature to extract, which makes implement of sweetening technology possible.

In 2005, ZRI of Chalco successfully developed sweetening digestion process, which got industrial application with oversea gibbsite in Zhongzhou Branch in 2006.

There are at least 3 refineries using sweetening digestion process in China.
There are about 350 Mt high sulfur bauxite in China.

The series of flotation Desulfurization tests of bauxite were completed by ZRI of Chalco.

High sulfur bauxite has been used to product alumina since 2010.
## Flotation Bayer Process for High Sulfur Bauxite

### Industrial Result of Desulfurization by flotation process(%)  

<table>
<thead>
<tr>
<th></th>
<th>$\text{Al}_2\text{O}_3$</th>
<th>$\text{SiO}_2$</th>
<th>$\text{Fe}_2\text{O}_3$</th>
<th>$\text{TiO}_2$</th>
<th>$\text{S}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailing</td>
<td>22.85</td>
<td>6.25</td>
<td>26.33</td>
<td>1.85</td>
<td>26.67</td>
</tr>
<tr>
<td>Concentrate</td>
<td>57.36</td>
<td>13.05</td>
<td>7.24</td>
<td>2.68</td>
<td>0.31</td>
</tr>
<tr>
<td>Ore</td>
<td>54.98</td>
<td>12.46</td>
<td>8.85</td>
<td>2.6</td>
<td>1.98</td>
</tr>
</tbody>
</table>
Part III

Prospect of China Alumina Industry
Prerequisite to realize sustainable development of alumina industry in China

- To effectively refrain rocketing rise of domestic alumina capacity
- To use as much oversea bauxite as possible, but this has been limited increasingly. For example, bauxite exporting is restricted in Indonesia and so on.
- To develop the effective alumina production process from low grade bauxite in order to reduce the energy consumption and the cost
- To seek alternative resource with the aim of lengthening the service life of domestic resources
- To develop the mining technologies of deep underground and under-coal bauxite to increase the amount of available bauxite
the admission policy for alumina industry to suppress excessive growth of alumina capacity

Bayer process:
alumina recovery: >81%,
energy consumption: <500 kgce/t-Al₂O₃,
capacity: >0.8mt/y

Other process:
alumina recovery: >90%,
energy consumption: <800 kgce/t-Al₂O₃,
capacity: >0.8mt/y

The service life of owned mine: >30 years
Flotation-Bayer process and Low Temperature Bayer process are main processes for alumina production.

Sintering process would be maintained only for value-added chemical alumina.

In the long run, it is to set up refineries in abundant bauxite countries.
Alternative Resources for Bauxite ---- Fly Ash

- It is necessary to seek alternative resources for China because of its severe shortage of high quality bauxite.

- Fly ash produced as high as 400 million tons per year. About one third contains alumina 30%-50%. From which even up to 15-20Mt alumina can be extracted.

- China government has carried out preferential policies to support and promote extracting alumina or aluminum from fly ash.
China’s efforts to Improve Alumina Industry

Alternative Resources for Bauxite ---- Fly Ash

Fly ash mountain in north-western China
China’s efforts to Improve Alumina Industry

- More and more research works have been carried out.
- $\text{Al}_2\text{O}_3$ extracting process from fly ash is mainly acid leaching and sintering process.
- About 100 patents on extracting $\text{Al}_2\text{O}_3$ from fly ash have been presented in China.
China’s efforts to Improve Alumina Industry

- An industrial refinery using fly ash is in operation with capacity of 0.3Mt/a.
- A refinery using fly ash is being constructed with capacity of 0.4Mt/a.
- A pilot test using acid leaching process from fly ash has been proceeding.
- A refinery using fly ash has been approved by government with capacity of 1 Mt/a.
China’s efforts to Improve Alumina Industry

- Fly ash will probably become the important alternative resources for alumina production in China.
- It is expected that importing oversea bauxite could be suppressed to great degree due to successfully extracting alumina from fly ash.
Conclusion

- China has been the world’s largest consumer of bauxite, the largest producer and consumer of alumina and aluminium.

- It is necessary to strengthen international cooperation to meet challenges from resources, energy and environmental protection for sustainable development of aluminum industry.
Thanks for your Attention!