Chinese mining industry: current status and future development

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# Current status

## Major minerals consumption

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Consumption (m tons)</th>
<th>Domestic production (m tons)</th>
<th>Import ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore</td>
<td>1139.6</td>
<td>186.9</td>
<td>83.6</td>
</tr>
<tr>
<td>Al ore</td>
<td>99.3</td>
<td>43.5</td>
<td>56.2</td>
</tr>
<tr>
<td>Ni ore</td>
<td>39.2</td>
<td>3.9</td>
<td>90.0</td>
</tr>
<tr>
<td>Cu ore</td>
<td>19.0</td>
<td>5.7</td>
<td>70.0</td>
</tr>
<tr>
<td>Mn ore</td>
<td>15.8</td>
<td>10.5</td>
<td>60.0</td>
</tr>
<tr>
<td>Cr ore</td>
<td>10.5</td>
<td>0.42</td>
<td>96.0</td>
</tr>
</tbody>
</table>
Challenges

1. High dependence on foreign resources

[Bar chart showing foreign trade dependence for various elements, with Nb, Cr, Ni, Zr, Fe, Co, Pt, Ta, Cu, Mn, Au, Al, U, K, Re, Ti, B, Pb, Be, Li.]

High risk of supply security

80%

50%
Challenges

Use more domestic resources to reduce the risk

Chinese resources

(1) Low grade
- **95%** of iron ores are low grade
- **50%** of coals are low-rank coal

(2) Complex in composition
- Panzihua iron ore: Fe, Ti, V, Co, Ni, Cr, Mn, Ga, Sc

1t iron ore concentrate: **2t waste rock + 2t tailings**
1t coal discharges **0.15-0.2t coal gangue**

High energy consumption and waste discharge
Challenges

2. Non-sustainable

(1) Large quantity of solid wastes discharged

- Total iron ore gangue/tailings: >10 billion tons, over 4000 iron ore waste rock piles or tailings dams
- Total coal gangue: > 5 billion tons, over 1600 coal gangue piles

(2) Huge amount of land occupied

- Occupied 4 million hectares land
- Increased 40,000 hectares every year

Agricultural land: 0.11 hm per capital, 43% of world average
National strategy

1. Low-grade ore utilization
   - Increase the recovery ratio
   - Decrease energy consumption
   - Reduce waste discharge

2. Comprehensive use of mining waste/tailing
   - Reduce land occupation and adverse environmental effect

3. Mined land reclamation
   - Increase farmable land
1. Low-grade ore utilization

New to develop **new technology**

Iron ore concentration extraction as an example

Separate **hematite** with $\text{Al}_2\text{O}_3$, $\text{SiO}_2$, $\text{MgO}$, etc.

Physical property

- **Density** → Gravitational separation
- **Surface** → Flotational separation
- **Magnetic** → Magnetic separation
- **Electrical** → Electrical separation
1. Low-grade ore utilization

New to develop **new technology**

Artificially increase property difference

\[
\text{Fe}_2\text{O}_3 + \text{H}_2/\text{CO} \rightarrow \text{Fe}_3\text{O}_4 + \text{H}_2\text{O}/\text{CO}_2
\]

- Fe recovery ratio: **70% to 90%**
- Heat recovery technology: energy consumption reduces **30%**
- Combined with cement industry: solid waste reduces **50%**
1. Low-grade ore utilization

Competitive with imported iron ore concentrate
2. Solid waste utilization

Coal gangue utilization as an example

- 1600 coal gangue “hills”, total amount 5 billion tons
- increased by 150-200 million tons per year
- Land occupation: 13,700 hectares
- Utilization ratio increased year by year, currently utilization ratio ~70%
2. Solid waste utilization

Utilization technologies

(1) **Thermal utilization** (power generation, combustion)
   - carbon content >20%, calorific value >6200 kJ/kg

(2) **Construction materials** (bricks)
   - calorific value 2100-6200 kJ/kg

(3) **Filling materials** (mine, roads)
   - calorific value <2100 kJ/kg

(4) **Pigments**
   - Special composition
2. Solid waste utilization

(1) Coal gangue power generation plants

- Over **250 coal gangue power plant** with total capacity **35 GW**, the largest capacity **330 MW**
- Consume **150 million tons** of coal gangue in 2013, **32%** of the total coal gangue discharged in 2013
2. Solid waste utilization

(2) Make construction materials

- Over **1000 coal gangue brick plants**, produce **13 billion bricks**
- Consume **56 million tons** of coal gangue in 2013, **12%** of the total coal gangue discharged in 2013
2. Solid waste utilization

(3) Filling materials

- 260 million tons of coal gangue were used to filling and remediating mines and in 2013, 56% of the total coal gangue discharged in 2013
2. Solid waste utilization

(4) White pigment from kaolinite coal gangue

- Established **30,000t/a** kolin white pigment in 2013
- Whiteness **95**, particle size: **0.1-5μm**
3. Mined land reclamation

(1) First stage (1949-1980s)
- Almost no land reclamation

(2) Second stage (1988-1998)
- “Land reclamation provision (1988)”: government promotes land reclamation; State investment on research and demonstration

(3) Third stage (1998-present)
- “Land management act” (1998): all damaged land must be remediated
- “Regulations on land reclamation monitoring” (2007): report on land damage and reclamation plan
- “Regulations on land reclamation” (2011): detailed requirements on the implementation
3. Mined land reclamation

All the damaged land must be remediated

(1) New mines

- Licence can be obtained before the land reclamation plan was approved by government
- Land reclamation fund must first be established before issuing the licence

(2) Mines in use

- Land reclamation plan and fund need to be established before renewing the licence

(3) Closed mines

- Government initiates to make land reclamation plan and establish the reclamation fund
Example of land reclamation

- **Revegetation of iron ore mine** *(Anshan steel)*
  - Established in **1948**, produce crude steel **331.93 million tons** in 2015
  - Has **6 iron ore mines**, produce **65 million tons** raw ore, get **18 million tons** iron ore concentrate
  - Formed **8 tailings dams** (4 still in use) of **1669 hectares**, and **8 waste rock fields** of **2094 hectares**
Example of land reclamation

- **Revegetation of iron ore mine (Anshan steel)**
  - Reclamation and revegetation start in **2007**
Example of land reclamation

- Revegetation of iron ore mine (Anshan steel)
  - Plant 6 million trees, 5.8 million bushes
Example of land reclamation

- Revegetation of iron ore mine (Anshan steel)
  - Reclamation area: **3000 hectares**, reclamation rate **90%**; revegetation rate **95%**
Example of land reclamation

- Revegetation of iron ore mine (Anshan steel)
  - Established 3 reclamation demonstration park
3. Mined land reclamation

- Change of agricultural land

2016
- Decrease: 336 km² due to construction, industrial and mining
- Increase: 293 km² due to reclamation

Decrease rate: from 500,000 ha to 40,000 ha per year
Summary

- Chinese mining industry faces great challenges in terms of supply security and sustainability

- Great efforts have been devoted to developing new technologies for low grade ores, to improve the efficiency and to reduce adverse effects to environments as well

- Chinese government has pushed comprehensive utilization of solid wastes of mining industry

- Compulsive regulations have been established to implement land reclamation and revegetation of mines
Thank you for your attention!