Crude quality impact on the aluminum industry

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Agenda

- Alcoa overview
- Calcined coke in aluminum smelting
- Closing comments
Alcoa at a glance

- Founded in 1888
- 200+ locations
- 31 countries; 61,000 employees
- $25.0 billion in revenues (2011)
- Lost workday injury rate 1/10 that of the avg. U.S. mfr. workplace
- Award-winning sustainability leadership
The aluminum leader for 125 years

- We invented the aluminum smelting process in 1888
- Alcoa is the largest producer of aluminum in the world
- Alcoa is the leader in aluminum technology and innovation
- Only aluminum company covering every stage of aluminum production:

**Upstream**
- Bauxite mining
- Alumina refining
- Aluminum smelting
- Aluminum recycling

**Midstream**
- Flat rolled aluminum

**Downstream**
- Fastening Systems
- Power & Propulsion
- Wheel & Transportation
- Building & Construction
- Forgings & Extrusions
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Petroleum coke is essential to the smelting process

2Al₂O₃ + 3C → 4Al + 3CO₂

Anodes are made from calcined petroleum coke

Source: Kashkhan at en.wikipedia;
Not all cokes can be used to produce anodes

<table>
<thead>
<tr>
<th>Grade</th>
<th>Appearance</th>
<th>Properties</th>
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</thead>
<tbody>
<tr>
<td>Fuel grade</td>
<td>Shot, Sponge</td>
<td>NA</td>
</tr>
<tr>
<td>Anode grade</td>
<td>Sponge, Porous</td>
<td>Sulfur &lt;4%, V &lt; 400 ppm, VM &lt; 13%</td>
</tr>
<tr>
<td>Electrode grade</td>
<td>Needle</td>
<td>S &lt; 0.6%, V &lt; 7 ppm, VM &lt; 5.5%</td>
</tr>
</tbody>
</table>

Source: Jacobs Consultancy
Changing refining landscape is impacting North American anode grade coke supply

<table>
<thead>
<tr>
<th></th>
<th>1983-85</th>
<th>Present</th>
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<tbody>
<tr>
<td>Sulfur</td>
<td>2.6-3.5%</td>
<td>3.5-6.5%</td>
</tr>
<tr>
<td>Vanadium</td>
<td>250-350 ppm</td>
<td>200-600 ppm</td>
</tr>
<tr>
<td>Structure</td>
<td>Sponge</td>
<td>Sponge /Shot</td>
</tr>
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- Increasing shift to fuel grade cokes
- **Higher degree of variability in coke supply quality from a single refinery**
- Decreasing supply of premium anode grade cokes

Source: Alcoa Analysis
Coke properties are driven by crude selection and refinery operations

**Crude Selections**
- Gravity
- Sulfur
- Asphaltenes
- Concarbon Residue (CCR)
- Metals content

**Refinery Operations**
- Desalting
- Chemistry Control
- Distillation
- Slops processing
- Coking conditions
- Decoking water quality

**Coke Properties**
- Structure
- Sulfur
- Metals
- Volatile Matter
- HGI
- Other impurities
Case studies: Refineries choosing to make anode grade coke

1. AG coke campaigns
   - 500 kMT, med. S, med. metals
   - Planned campaigns for FG /AG coke
   - Batch AG mode
   - Increased revenue ~$18 MM for 30% AG production

2. Chemistry control
   - 100 kMT, med. S, low metals, high Fe
   - Planned VTB imports
   - Continued phosphoric acid addition results in high phosphorous
   - Opportunity to increase coke revenue by ~$5-10 MM

Source: Jacobs Consultancy
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Changes in crude quality and refinery operations have a significant impact on the aluminum industry

- Long term quality changes
- Short term quality excursions/ unpredictability

You can make a difference

- Increased anode grade production can be mutually beneficial
- Predictability in coke/ crude quality helps

We are just as interested in understanding the changes in the crude flows and its impact to refinery operations as you are
Our Values
We live our Values every day, everywhere, collaborating for the benefit of our customers, investors, employees, communities, and partners.

Integrity
We are open, honest, and accountable.

Respect
We treat all people with dignity and provide a diverse, inclusive work environment.

Environment, Health and Safety
We work safely, promote wellness, and protect the environment.

Innovation
We creatively transform ideas into value.

Excellence
We relentlessly pursue outstanding and sustainable results.