Carbothermic Reduction of Red Mud in an EAF and subsequent Recovery of Aluminum from slag by Pressure Leaching in Caustic Solution

Frank Kaußen, Bernd Friedrich
Motivation and Overview

Red mud composition

<table>
<thead>
<tr>
<th>Main components in wt.-%</th>
<th>Al$_2$O$_3$</th>
<th>Fe$_2$O$_3$</th>
<th>SiO$_2$</th>
<th>CaO</th>
<th>TiO$_2$</th>
<th>Na$_2$O</th>
<th>Cr$_2$O$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Mud</td>
<td>27</td>
<td>28.5</td>
<td>13.1</td>
<td>3.8</td>
<td>8</td>
<td>7</td>
<td>0.35</td>
</tr>
</tbody>
</table>

- **Carbothermic Reduction in EAF**
  - Addition of lignite coke as reductant
  - Addition of lime as flux
  
  → **Aim:** Preconcentration of alumina and maximum recovery of iron

- **Pressure leaching of ground slag**
  - Various caustic soda concentrations (200-760 g/l)
  - NaF$_2$ (50 g/l) and Na$_2$CO$_3$ (10 wt.-%) Addition

  → **Aim:** Maximum recovery of alumina
### Results carbothermic reduction and leaching

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</tr>
<tr>
<td>Slag with lime addition</td>
<td>40</td>
<td>1.1</td>
<td>18</td>
<td>29.1</td>
<td>11</td>
<td>2.8</td>
<td>0.07</td>
</tr>
<tr>
<td>Slag without lime addition</td>
<td>50</td>
<td>2.3</td>
<td>20.7</td>
<td>7.7</td>
<td>13.8</td>
<td>7.7</td>
<td>0.14</td>
</tr>
<tr>
<td>Leached Residue</td>
<td>2.2</td>
<td>0.5</td>
<td>20.7</td>
<td>38.7</td>
<td>18.2</td>
<td>11.9</td>
<td>0.09</td>
</tr>
</tbody>
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- Maximum preconcentration up to 50 wt.-% without lime addition, but higher iron losses due to high slag viscosity
- 95 % aluminum recovery at NaOH > 550 g/l @ 250°C
- Leached residue contains only ~2 wt.-% Al$_2$O$_3$ and ~0.5 wt.-% Fe$_2$O$_3$
Results Fluoride addition

- Fluoride addition does not hinder the alumina recovery
- Silica dissolution is fastened
- Intensified silica precipitation during the leaching at lower NaOH concentrations (< 300 g/l)
  → At the end lower silicon contents in leach liquor
Thank you for your attention!