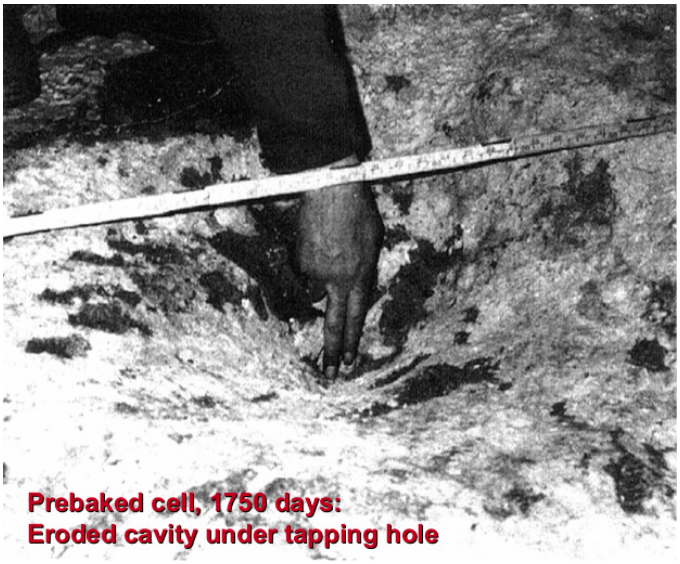
Abrasion of Cathodes in Aluminium Electrowinning

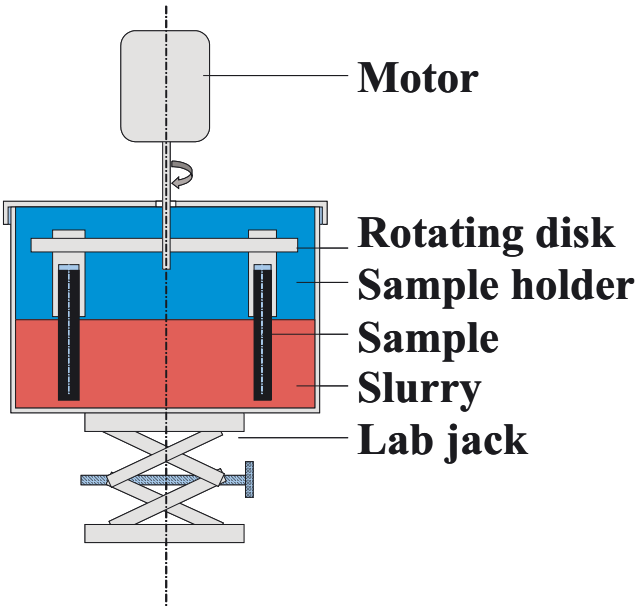
Background and Relevance

Physical abrasion in an aluminium electrolysis cell is most frequently believed to be caused by the motion of sludge or muck between the metal pad and the carbon cathode surface. The sludge or muck, is a two phase mixture of a saturated cryolite melt with undissolved alumina particles. The movements of the metal pad cause the muck to act as an abrasive slurry.
The picture shows an eroded cavity under the tapping hole in a prebaked cell.



Experimental Setup

The sketch shows the principle of the room temperature test method developed to quantify the abrasion resistance of carbon cathode materials. The method has also been developed for material testing at 960 °C with molten electrolyte with excess alumina.



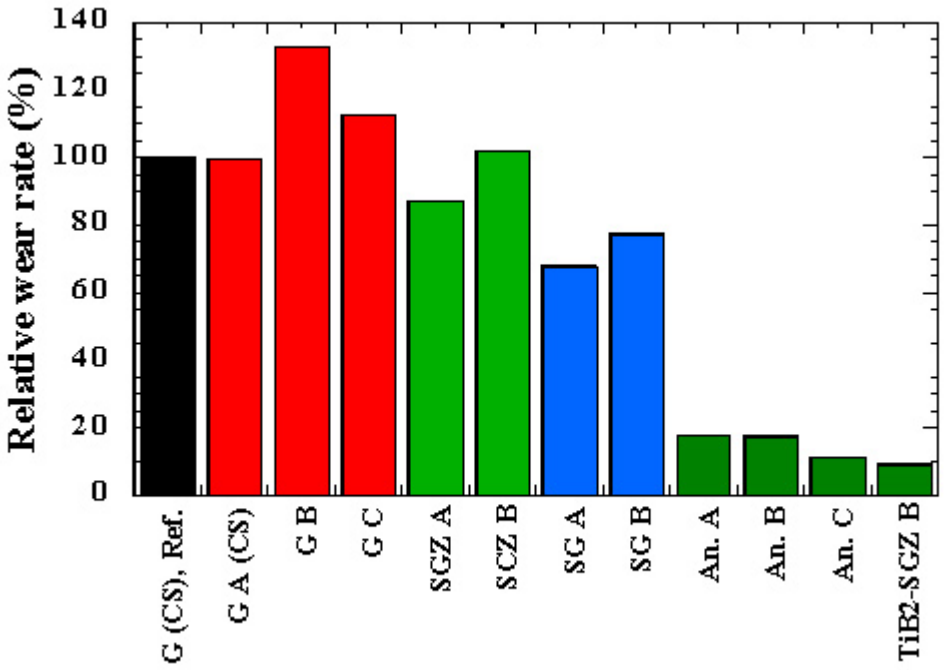
Typical test parameters at room temperature:
Slurry:
Alumina in a sodium polytungstate solution (density » 2.6 g/cm^3)
Sample size:
10 or 30 mmØ x 65 mm
Rotation speed:
120 ± 5 rpm
Rotation time:
6 hours

The wear (volume change) is measured relative to a reference material, in this case graphite.

Abrasion Results

Different carbon cathode materials may be ranked by the abrasion wear at room temperature. Test results are in good agreement with industrial experience. It was also found that the hardness value of the materials are of little significance with respect to the abrasion wear properties.

The figure shows room temperature abrasion wear of graphite (G), semigraphitized carbon (SGZ), semigraphitic carbon (SG), and anthracite (An).
The observed ranking with respect to abrasion resistance is (ranked from worst to best):
G = SGZ < SG < An
Coating one of the least abrasive resistant materials with TiB_2 increase the resistance significantly, and places it among the most resistant materials.



Reference

Xianan Liao and Harald A. Øye, "Method for Determination of Abrasion Resistance of Carbon Cathode Materials at Room Temperature", Carbon 34(1996)649-661.

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