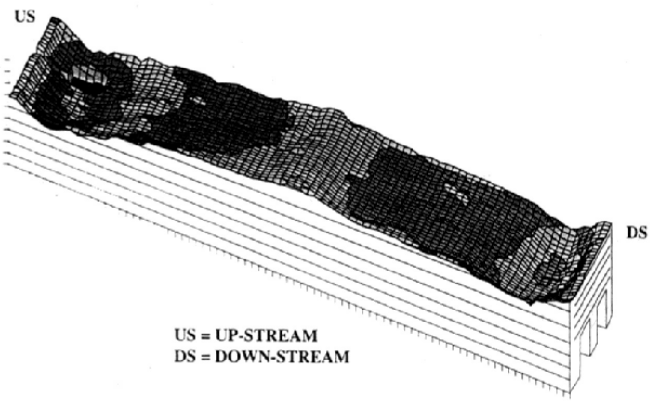
High Temperature Wear

Background and Relevance

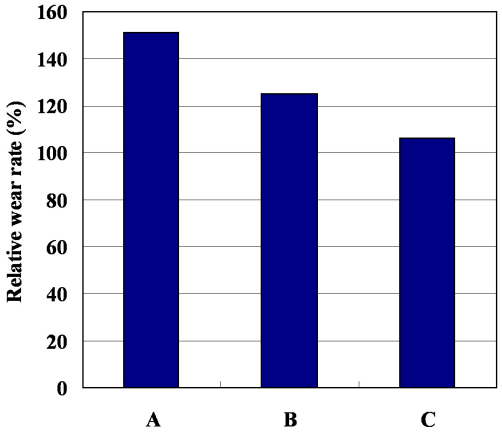
Wear in aluminium cells is a result of physical abrasion or chemical wear, or a combination of these mechanisms.

Physical wear in an aluminium electrolysis cell is most frequently believed to be caused by the motion of alumina slurry between the metal pad and the carbon cathode surface. This wear will be enhanced in high velocity areas.



Eroded graphitized block of a high intensity pot (61 months old).

Chemical wear is beleived to be due to electrochemical formation of Al_4C_3. This wear has been found to increase with increased current density. Earlier results showed this wear to be independent of carbon material although unpublished results indicate lower chemical wear for more graphitic materials.

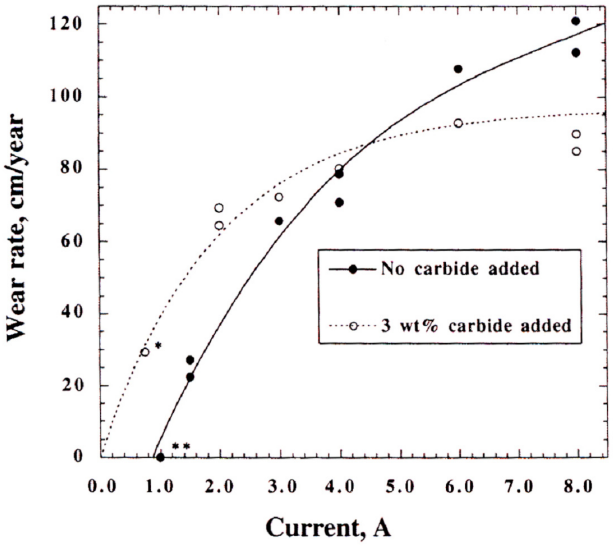


The relative importance of the two mechanisms is yet not quantified.

Typical results from chemical wear studies are shown in the Figures below. Wear may be studied as a function of current density or presented as relative wear in comparison tests.

In the Figure above relative wear in a comparison test is shown.

In the Figure to the right a current density study of one material subject to two different experimental conditions is shown.



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Experimental Conditions

The sketch shows the principle of the high temperature test method developed to quantify chemical wear of carbon cathode materials.

Typical test data is:

Melt: Cryolite ratio 2.2, saturated with industrial alumina

Temperature: 980 °C

Rotation speed: 0.6 m/s (or as specified by the customer)

Current density: 0.75 A/cm^2 (or as specified by the customer)

Electrolysis time: 3 hours

Before measuring the chemical wear, frozen bath is removed in an $AlCl_3$ solution. The wear (volume change) may be measured relative to a reference material.

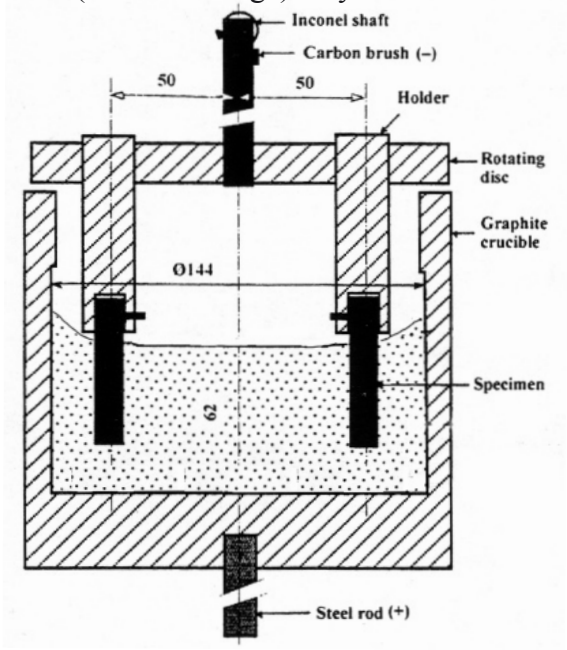

Figure. Layout for measuring chemical wear at industrial temperatures.

Reference:

X. Liao and H.A. Øye, Carbon Cathode Corrosion by Aluminium Carbide Formation. Light Metals 1999, p. 621.

For further information, please contact:

Anne Støre **Phone: +47 982 30 458**
Arne Petter Ratvik **Phone: +47 922 96 156**
E-mail: primalab@sintef.no

SINTEF Materials and Chemistry
Energy Conversion and Materials
N-7465 Trondheim, Norway
Phone: + 47 932 49 860
Fax: + 47 73 59 11 05
http://www.sintef.no
E-mail: primalab@sintef.no

The Norwegian University of Science and Technology
Faculty of Natural Sciences and Technology
Department of Materials Technology
N-7491 Trondheim, Norway
Phone: + 47 73 59 50 00
Fax: + 47 73 59 08 60
http://www.ntnu.no