Presentation of a New Anode Stub Hole Design
Reducing the Voltage Drop of the Connection
by 50 mV

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Plan of the Presentation

• Introduction
• New stub hole design strategy
• Test of new stub hole designs using the TEM model
• Conclusions
Introduction

The voltage drop at the anode cast iron-carbon interface is about 30% of the total anode voltage drop.
Introduction

That interface contact resistance can be measured and measurements show that it varies a lot from anode stub hole design to anode stub hole design.

Introduction

Observed variations in contact resistance are linked to the measured fact that this contact resistance is pressure and temperature dependent.

\[
R_e = A(T) - B(T)\exp\left(\frac{P}{C(T)}\right)^{D(T)}
\]

\[
A(T) = \exp\left(\frac{a_0 + a_1T}{1 + a_2T + a_3T^2}\right)
\]

\[
B(T) = \exp\left(\frac{b_0 + b_1T}{1 + b_2T + b_3T^2}\right)
\]

\[
C(T) = c_0 + c_1T
\]

\[
D(T) = d_0 + d_1T
\]

Introduction

This explains why stub hole designs neglecting to account for the pressure dependency are not working


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Introduction

Now fortunately Thermo-Electro-Mechanical (TEM) models have been developed that well represent that dependency.

Introduction

In 2011, that TEM model has been used to design a new type of stub hole aiming at reducing the anode voltage drop.

Ref: M. Dupuis and V. Bojarevics, Retrofit of a 500 kA cell design into a 600 kA cell design, ALUMINIUM 87(1/2), 2011, 52-55.
New stub hole design strategy

- No current is flowing between the bottom of the stub and the base of the carbon stub hole because no contact pressure is developing at that interface.
- Radially, the pressure develops because the steel stub expands more than the carbon block.
- The stub also expands vertically but nothing is preventing it to move up while it expands.
- In order to get contact pressure there too, the stub needs to be prevented to be free to move up while it expands vertically.
Standard stub hole

Standard stub hole with a locking key in the stub

With and without locking key in the stub

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Drilled (or machined) stub hole

In 2003, a drilled stub hole design was presented

Drilled (or machined) stub hole

A drilled stub hole design can also be used to vertically lock the stub with and without cast iron under the stub.
Optimized drilled stub hole shape with stub lock key

Optimization of the shape using an axisymmetric TEM model
Optimized drilled stub hole shape with stub lock key

Optimization of the shape using an axisymmetric TEM model
Conclusions

• Richard & Dupuis have developed and patented a new concept of forcing contact pressure on the bottom of the stub.

• 50 mV savings for a 360 ktpa smelter is 2.9 MUSD for 50 USD/MWh cost of energy (high energy cost).

• The next test is to demonstrate mV savings on experimental test rig.