ALUMINUM

Project Fact Sheet

Wettable Ceramic-Based Drained Cathode Technology

Benefits

The potential benefits of this technology include:

- Total annual energy savings of 126 trillion Btu of the energy required to produce electricity for electrolysis
- Increasing cell energy efficiency by 13 to 20 percent
- Longer cell life

Applications

This technology will provide stable ceramic cathode lining materials for reduced energy consumption during aluminum production.

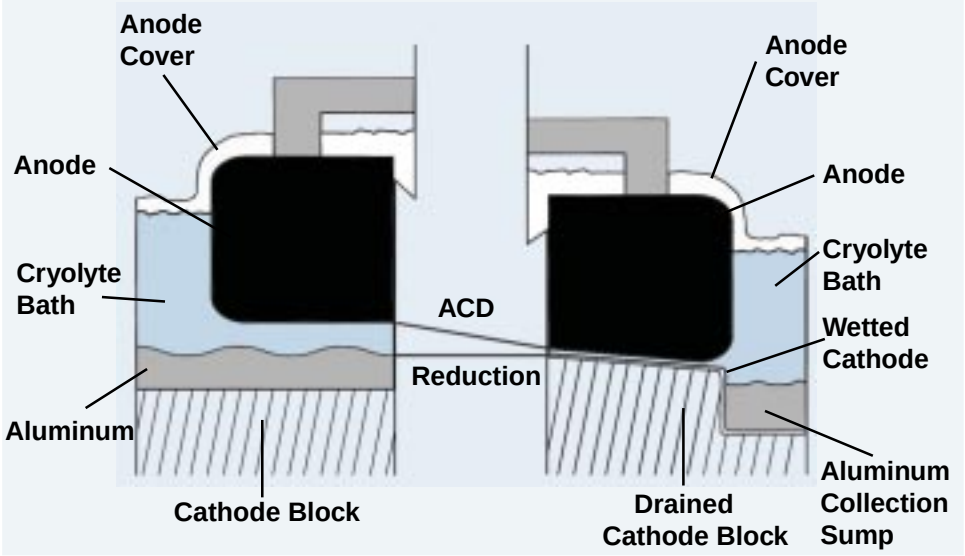
New technology for aluminum electrolysis cells will reduce energy during aluminum production

Wetted Cathode technology has the potential to reduce energy consumption significantly. It offers the opportunity to fundamentally change the physical operating characteristics of the Hall Heroult cell.

The cathodic surface in existing cells is a molten metal aluminum pad. The large electrical forces in the cell cause the pad to move and undulate giving the pad a flowing uneven surface. The anode must be positioned to avoid contact and electrical shorting with the metal pad. The development of a wetted cathode allows the metal to be drained away. A drained cathode presents a flat stable surface and the anode cathode distance (ACD) can be decreased. The ACD contributes about 30 - 40% of the total energy demand in a cell. Decreasing the ACD proportionally decreases its contribution to the total energy demand.

Project partners successfully developed and evaluated ceramic-based cathode materials that can be retrofitted into existing reduction cells. These ceramic materials have high electrical conductivity, thermal shock resistance and are easily machined. Project partners evaluated these materials on a pilot scale and developed the engineering packages necessary to incorporate these materials into existing cells.

Cathode Cells



Conceptual drawing of a conventional Hall-Heroult cell versus a drained cathode cell. Note the decreased anode cathode distance (ACD).

Project Description

Goal: The goal of this program was to identify and test the material performance of wetted ceramic cathode tiles.

The project partners developed ceramic-based materials and necessary engineering packages to retrofit existing reduction cells in order to reduce the energy consumption required for making primary aluminum.

The ceramic materials were tested in a drained cathode configuration and provided a stable wetted cathodic surface. Eliminating the wavy, irregular molten aluminum pad as the cathode and replacing it with a stable ceramic surface allowed the anode-to-cathode distance to be reduced, thereby reducing the cell's electrical resistance. Stable operation of the new cathode technology required the development of a more insulating lining design and new process control algorithms for the management of alumina feeding, anode bridge movements, and increased sensitivity to cell instability.

Project Summary

A scaled-down commercial Hall Heroult cell with newly developed cathode materials and a drained sump operated for 1500 hours. The demonstration showed that the anode/cathode distances could be decreased with this design. This lowers voltage and electricity consumption. The project partners:

- Confirmed best material composition for long-term survival in the molten aluminum/bath environment.
- Identified suitable methods for installation of wettable cathode tiles.
- Confirmed operational benefits at 1" anode-cathode distance.
- Confirmed operational benefits of the drained cathode.
- Confirmed cell design heat balance and engineering concepts.

Significant engineering problems remain to be overcome before this technology can be adopted for commercial use. Severe erosion/corrosion of the sump walls occurred in the 1500-hr test. The damaged area extended completely around the sump perimeter and into the cell floor. It affected the positioning/interlocking of the cathode tiles adjacent to the sump. A new sump design will be required in order to avoid this damage.

The tiles tested were not fixed to the cathode block surface. They were held in place by their interlocking design. Anode effect suppression procedures, which require anodes to contact the metal pad, will need to be modified to accommodate the tiles.

Commercialization Plan

The project partners could incorporate this technology into Hall Heroult cells as they are scheduled for rebuilding. Advanced Refractory Technologies has the commercial incentive to rapidly improve and distribute their cathode tiles to an industry looking for efficient components.

Project Partners

Alcoa Incorporated
Alcoa Center, PA

Advanced Refractory Technologies
Buffalo, NY

Kaiser Aluminum & Chemical Corporation
Kaiser Aluminum Mead Works Plant
Mead, WA

For additional information, please contact:

Project Information
Henry Guerke
Alcoa Incorporated
Phone: (724) 337-2557
Fax: (724) 337-2209
henry.guerke@alcoa.com

Aluminum Program
Industrial Technologies Program
Clearinghouse
Phone: (800) 862-2086
clearinghouse@ee.doe.gov
http://www.oit.doe.gov/clearinghouse/

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov.

Visit our home page at www.oit.doe.gov/aluminum

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

March 2003