Presentation of an Improved Reversed Compensation Current (RCC) Busbar Concept Using Less Busbar Weight

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Plan of the Presentation

• Introduction
• State of the art in busbar design
• A new busbar concept: Reversed Compensation Current
  – Original RCC concept
  – Improved RCC concept
• RCC opportunities for future smelter design
• Conclusions
Introduction

- Cell stability influenced by magnitude of $B_z$ in metal pad
- $B_z$ is the vertical component of the magnetic field
- $C_x$ is the difference between the $B_z$ positive value in one end of cell and the $B_z$ negative value in the other end

State of the art in busbar design

Internal Compensation Current

RA-400 Technology (undisclosed busbar design)

- 2003: RA-300 320 kA
- 2005: RA-400 415 kA
- 2010: RA-500 500 kA

Ref: I. Rebrik, Innovative approaches to business in RUSAL, 2015
State of the art in busbar design

Internal Compensation Current with asymmetric busbar network

Ref: DING Ji-lin, LI Jie, ZHANG Hong-liang, XU Yu-jie, YANG Shuai and LIU Ye-xiang, Comparison of structure and physical fields in 400 kA aluminum reduction cells, J. Cent. South Univ. (2014) 21, pp 4097−4103
State of the art in busbar design

Internal Compensation Current with asymmetric busbar network

Ref: M. Dupuis and V. Bojarevics, Retrofit of a 500 kA cell design into a 600 kA cell design, ALUMINIUM 87(1/2) (2011), pp 52-55
State of the art in busbar design

1987 Pechiney patent with **External Compensation Current**

Ref: Joseph Chaffy, Bernard Langon and Michel Leroy, Device for connection between very high intensity electrolysis cells for the production of aluminium comprising a supply circuit and an independent circuit for correcting the magnetic field, US patent no 4713161 (1987).

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State of the art in busbar design

1987 Pechiney patent with External Compensation Current

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State of the art in busbar design

2006 Hydro Aluminium patent with Combined types of Compensation Current

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New busbar concept
Reversed Compensation Current (RCC)

• Completely different concept from ICC, ECC, and CCC

• Same purposes as the others: minimize vertical $B_z$ and provide a scalable solution to the cell stability amperage

• RCC is similar to ECC: there is no internal compensation current busbars, and the $B_z$ is compensated by external current busbars

• RCC requires the addition of downstream risers located on the downstream side of cell to produce a perfectly anti-symmetric $B_x$

• Contrary to ECC though, RCC compensation busbars:
  1) are located close to the internal potline current busbars routed under cell
  2) carry current in the opposite direction to the potrow
New busbar concept
Reversed Compensation Current (RCC)

Original version of RCC at 500 kA

Original RCC busbar network concept with downstream risers

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New busbar concept
Reversed Compensation Current (RCC)

Original version of RCC at 500 kA

Corresponding $B_z$ and $B_x$ magnetic field components
New busbar concept
Reversed Compensation Current (RCC)

Original version of RCC at 500 kA

Corresponding steady-state bath-metal interface deformation and steady-state metal pad flow velocity field.
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

The improved version involves a second innovation in order to drastically reduce both the busbar weight and the busbar voltage drop:

Extracting 100% of the cell current on the downstream side using copper bars having similar sizes as standard steel collector bars.
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

Thermo-electric model metal pad current density
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

Thermo-electric model metal pad current density
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

Improved RCC busbar network concept with alternating risers
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

Corresponding $B_z$ and $B_x$ magnetic field components
New busbar concept
Reversed Compensation Current (RCC)

Improved version of RCC at 500 kA

Corresponding steady-state bath-metal interface deformation and steady-state metal pad flow velocity field

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RCC usage opportunities for future smelter design

- RCC carries the full potline current in the compensation busbars but in the opposite direction to the potrow

- Possibilities:
  - This creates the option to return the potline current in these compensation busbars instead of in a return potrow located in a second potroom
  - An odd number of potroom(s) is possible for new smelter design including only 1
  - Potlines can be located in close proximity – potrow current running in one direction is cancelled out by the current in the compensation busbars running in the opposite direction
RCC usage opportunities for future smelter design
Conclusions
Original RCC Concept

• A new busbar network concept has been developed: Reversed Compensation Current

• Easily extendable to any cell size (demonstrated at 750 and 1500 kA)

• Similar to ECC since RCC has no ICC, meaning no busbars are wrapping around cells and $B_z$ is compensated by external busbars

• Different from ECC as RCC busbars are located under the cell close to the potline current busbars also routed under the cell carrying current in the opposite direction, thereby neutralizing their magnetic influence opening the door to smelter design having an odd number of potrow(s) and multiple potlines in a very small footprint
Conclusions
Improved RCC Concept

- An improved Reversed Compensation Current busbar network concept has been developed.
- The improved version involves a second innovation in order to drastically reduce both the busbar weight and the busbar voltage drop:
  - Extracting 100% of the cell current on the downstream side using copper bars having similar sizes as standard steel collector bars
- A 500 kA cell with copper collector bars extracting 100% of its current on the downstream side and using the improved alternating anode risers RCC busbar configuration is predicted to run at 12.35 kWh/kg while operating at 3.5 cm ACD.