To Improve Gross Carbon Consumption in High Purity Aluminium Production

Dubai Aluminium (DUBAL)

Department:
Process Control Potrooms - Smelter Operation

Members:
Dr. Maryam M. Al Jallaf, H.R. Devadiga, Dr. D. Whitfield, J. Blasques, H. Dias, F. Majid, MSW Ali, E. Mofor,
Abdulla Obaid, A. Sharma & Dr. Adam Sherrif
“Before” Situation

Old Process Map

Problems Found:

➢ Due to small size of anode, it needs to be replaced frequently (short shift life) which is leading to High Gross Carbon Consumption (GCC).

➢ Required extra mould (compactor) change in Paste Plant to make different sizes of anodes.

➢ Difficulty in logistics as different anode size needs to be transferred and stored separately.
Definition of Gross Carbon Consumption (GCC)

Mathematically, GCC is defined as:

\[
GCC \left( \frac{\text{kg C}}{\text{kg Al}} \right) = \frac{\text{Weight of new anodes}}{\text{Weight of Aluminium produced}}
\]

Anodes are consumed according to the reaction:

\[
2\text{Al}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Al} + 3\text{CO}_2
\]
Problem Statement

Using small anodes of 1485 mm length in High Purity (HP) electrolysis cells enforces the anodes to be frequently replaced at short life cycle of 64 shifts, which results in higher gross carbon consumption at 0.687 kg C/ kg Al compared to other cell technologies / mode of operations.

Reduction 5% of gross carbon consumption will enable optimization of unit cost and contribute into green metal production, which is definitely safeguard the environment and reduce carbon footprint.
Root Cause Analysis

The team conducted 5 Why’s questioning technique to find out root causes. The team explored cause & effect relationship, as below:

**Problem: Gross carbon consumption is high in HP cells**

- Because of short anode life of 64 shifts per cycle
- Because higher shift life will result in metal contamination
- Because of thin butt leading to stub wash
- Because not enough carbon left over under anode stub
- Because of small anode size

To increase the shift life, amount of carbon need to be increased by increasing the size of HP anodes.
Improvement Plan

Improvement plan is based on trialling long anodes (1515 mm length) for the first time in high purity cells and following actions were decided accordingly:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Actions</th>
<th>Responsibility</th>
<th>Target Date</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Assess usage of larger anodes (1515mm length) at higher anode shift life while maintaining metal purity.</td>
<td>PCPR &amp; Operation</td>
<td>Feb 2012</td>
<td>Feb 2012</td>
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<tr>
<td>2.</td>
<td>Raise Parameter Change Request “PCR” for the proposed changes</td>
<td>PCPR</td>
<td>Feb 2012</td>
<td>Feb 2012</td>
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<td>3.</td>
<td>Start with 5 cells, use large anodes and increase anode shift life</td>
<td>PCPR &amp; Operation</td>
<td>Mar 2012</td>
<td>Mar 2012</td>
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<td>4.</td>
<td>Extract data of butt size measurements from Rod Tracking System directly and publish it into Reporting System (RPMS)</td>
<td>PCPR &amp; PCRM</td>
<td>Apr 2012</td>
<td>May 2012</td>
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<td>5.</td>
<td>Collecting data, perform required analysis and discussion</td>
<td>PCPR &amp; Operation</td>
<td>May 2012</td>
<td>May 2012</td>
</tr>
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<td>6.</td>
<td>Increase number of population for additional 5 cells; total 10 cells at 68 shift life</td>
<td>PCPR &amp; Operation</td>
<td>May 2012</td>
<td>May 2012</td>
</tr>
<tr>
<td>8.</td>
<td>Trialling 72 anode shift life in another 5 HP cells</td>
<td>PCPR &amp; Operation</td>
<td>Jun 2012</td>
<td>Jun 2012</td>
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<td>9.</td>
<td>Conclude the trial, share the results &amp; spread the knowledge</td>
<td>PCPR &amp; Operation</td>
<td>Oct 2012</td>
<td>Oct 2012</td>
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<td>10.</td>
<td>Endorse Best Practices and roll over the change to all 96 cells</td>
<td>PCPR</td>
<td>Feb 2013</td>
<td>Feb 2013</td>
</tr>
</tbody>
</table>
“After” Situation

**New Process Map**

- Green Paste
- Anode 1515 mm Compactor
- Baking & rodding Anode
- Storage & Transport 1515 mm Anode
- Usage of 1515 mm Anode in HP & PPF Cells

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**Improvement Found:**

- Anode shift life increased by 8 shifts.
- Gross Carbon consumption reduced by 51 kg C/mt Aluminium.
- Extra mould change eliminated in Paste Plant.
- Improve anode production capacity & inventory level.
- Ease in logistics.

**Shift Life Cycle**

- BEFORE: 64
- AFTER: 72

**GCC (kg C/kg Al)**

- BEFORE: 0.687
- AFTER: 0.636

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Small anode (1485mm length)  
Long anode (1515mm length)
Benefits

**Environment**
- Reduce carbon consumption by \(\sim 51 \text{ kg C/m}\text{t Al} \ (\sim 2,595 \text{ mt C}} \) annually \(\approx 2,154 \text{ anode blocks}\) and raise environment awareness.

**Financial Benefits**
- Audited recurring annual gain of AED 4.3 Million
- Increase in anode life by at least two cycles from 64 to 72 shifts and potentially to 76 shifts.

**Smelter Logistics & Anode Production Capacity**
- Improve logistics of the smelter, improve anode production capacity, and optimize inventory level & existing resources.
- Decrease crane usage time and associated maintenance.
- Eliminate mould change over time from 110 hours/year to zero.

**Application of Quality Tools**
- Excellent practice for systematic process improvements which are the driving factor for DUBAL success and in line to DUBAL’s vision “To be one of the best companies in the global Aluminium industry”.
- Spread the culture and knowledge of continual improvements.
Participation

Team members performed the following project roles and tasks:

<table>
<thead>
<tr>
<th>Name</th>
<th>Functional Role</th>
<th>Project Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dr. Maryam Al Jallaf</td>
<td>Snr. Manager Process Control Potrooms &amp; Cell Lining</td>
<td>Team leader</td>
</tr>
<tr>
<td>2. Devadiga H. R.</td>
<td>Manager D20</td>
<td>Endorse best practice and implementation</td>
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<tr>
<td>3. Jose Blasques</td>
<td>Acting Manager D18</td>
<td>Review/discussion/implementation from operation</td>
</tr>
<tr>
<td>4. Dr. Daniel Whitfield</td>
<td>Manager Project, D18</td>
<td>Optimization of KPIs. Knowledge of historical events in HP cells</td>
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<td>5. MSW Ali</td>
<td>Process Control Engineer</td>
<td>Follow up, analysis, report the progress periodically.</td>
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<tr>
<td>6. Handerson Dias/A. Obaid</td>
<td>Superintendent Potrooms</td>
<td>Anode setting quality &amp; cell care</td>
</tr>
<tr>
<td>7. Edouard Mofor/Dr. Adam Sherrif</td>
<td>Snr. Process Control Engineer /Superintendent Mobile Equipment Services</td>
<td>Measure and report butt weights and relevant parameters using RTS /manually</td>
</tr>
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</table>

Employees of different levels, skills and experience are pulled & united together in one team to achieve excellent results.
Standardization

System and reports established for reporting the progress and sustaining the improvements

• Weekly KPIs are being issued and distributed to all team members.
• Report of butt parameters is developed, and released on weekly basis by process information team.
• Work instructions are deployed and audited through daily walkabouts.
• Usage of 1515mm length anodes is standardised for D18 and CD20 cell technologies.
Horizontal Deployment

• Roll-over to the rest of HP cells in Potline 1 & 3 (total of 96 cells) and standardise the operation activities.

• Embrace and endorse the best practice and generalize it across D18 cell technology.

Plan for further refinement of the process:
Initiating another project to further increase anode shift life to 76 shifts per cycle

Team recognition:
Project team was rewarded by Quality Assurance Department
Single Point Lesson

"Success can not be achieved unless trials for improvements are done."

Area Owner Comment

“This project proved that original design can’t be the stop sign for further improvement. It saved 7.4% of gross carbon consumption and increased anode shift life by 8 shifts, reduced workload and improved safety. Moreover, it standardized the usage of 1515mm in both HP and PPF cells by eliminating production of 1485mm anode from the plant. Financially, this project has a benefit of AED 4.3 Million annual recurring and optimizes existing resources and anode production capacity.”

Dr. Maryam M. Al Jallaf, Senior Manager Process Control Potrooms and Cell Lining
Q & A

Thank you

Together we shine
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