Optimizing Aluminium Reduction Cell Start-up- A Semi-Conventional Approach at Sohar Aluminium

Agnello Borim[1], Ciro Kato[2], Abdullah Al Dhahli[3], Swapnil Sahu[4] and Abdullah Al Yarubi[5]
1.Chief Operating Officer
2. Technical Manager
3. Technical Superintendent
4. Reduction Technical Specialist
5. Lead Engineer- Reduction Technical
Sohar Aluminium Company L.L.C, Sohar, Sultanate of Oman
Corresponding author: Abdullah.alyarubi@Sohar-Aluminium.com, Swapnil.sahu@Sohar-Aluminium.com
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Abstract

Sohar Aluminium ensures non-stop development, especially in minimizing greenhouse gas emissions through boosted cell performance. Perilous to achieving this target is the continuous development of the procedures for the aluminium reduction cell start-up, as this will enhance greatly the performance, life longevity, productivity and environmental footmark. This paper outlines a novel semi-conventional methodology developed at Sohar Aluminium to enhance cell preheating, start-up, and early life operation, addressing both performance and safety concerns.

Traditional dry start-up and preheating methods, while effective, normally results in non-homogenous temperatures across pot and are labour intensive, which represent safety risks. To reduce these challenges, Sohar Aluminium improved its cell start-up process by implementing a group of changes, focused on minimizing manual intervention and achieving a uniform preheating process. This new approach, branded by a "semi-conventional" strategy, bonds the gap between well-known practices and innovative enhancements.

The paper evaluates the effectiveness of these changes by analysing key performance indicators (KPIs) for preheating and start-up. It details the technological and procedural advancements as well that led to a safer, more efficient, and sustainable cell start-up, ultimately extending cell life and improving operational excellence.

Keywords: Aluminium reduction cell, Dry Start-up, Homogeneous preheating, Work practices, Sustainability.

1. Introduction

1.1 Sohar Aluminium Facility Overview

The Sohar Aluminium smelter runs with a single potline consisting of 360 reduction cells. The potline is divided into two pot rooms and utilizes AP40/42S technology, supporting a maximum annual production capacity over 400 kt of primary aluminium. In addition to the reduction lines, the facility holds an integrated carbon plant that manufactures baked anodes required for the electrolysis process. A dedicated cast house is also on-site, where the liquid aluminium is sent for casting into various product forms, including standard ingots and sows, ready for domestic and international markets.

Sohar Aluminium is equipped with state-of-the-art process control systems and aligns with global operational best practices. Supporting its smelting operations, the company operates a dedicated

1000 MW natural gas-fired power plant, ensuring a stable and efficient energy supply. The facility also benefits from direct access to a port terminal located within the Sohar Industrial Port area, allowing for all-in-one logistics, raw material imports, and product exports. This integrated process outlines the reliability and efficiency of the overall operation [1].

As part of its broader industrial impact, Sohar Aluminium has actively contributed to the growth of the local aluminium company. The company has played a foundational role in the founding of four downstream aluminium processing facilities, in which all are operational and utilize metal produced at the Sohar Aluminium [2].

1.2 Primary Aluminium Electrolysis Process

Hall–Héroult process is the only industrial process for smelting aluminium on industrial scale. The process starts by extracting of (Al_2O_3) through the Bayer process by purifying bauxite. The alumina then dissolves in the cryolite solution (Na_3AlF_6), under an excessive temperature in electrolytic cell. A direct current then passes through the pot, where the alumina is electrochemically reduced, yielding metal that is “Aluminium” and oxygen ions that directly bond with carbon of the anodes, that produce CO_2 carbon dioxide. As of denser molecular weight of aluminium metal, it sinks and accumulate in the pool of the pot and is regularly tapped for extra handling. Simultaneously, carbon dioxide is produced below the anodes as of side reactions of the process, which is extracted thru GTC duct system.

The pot cell structure is a large, rectangular steel vessel lined with a refractory material and carbon blocks. Inside this container, a carbon anode block suspended at top and acts as positive pole, while the negative pole cathode block is setting at bottom of the pot. The space between the two blocks is filled with an electrolyte, mainly composed of cryolite (Na_3AlF_6) with the alumina dissolving inside. Readiness of this type of cell is complex, as this presents a key stage for the effective process of aluminium cell, beginning with shell construction and a precise and layering of refractory and insulation materials. The process starts with delining the old shell then followingly rebuilding it at a dedicated lining workshop. The ready new shell, will be shifted to the new pot location in which it will undergoes preparation for energization and preheating, in which the pot will spend time in this phase to be ready for the start-up were bath will be added alongside metal after 24 h. The final step arrives to normalize the pot in the early life stage, to bring it to full production.

This start-up method has technical difficulties, as well holds substantial influence over the enduring performance and efficiency of the pots. Therefore, the continuous improvement and finetuning of start-up procedures is a main priority, and dominant for better long life, productivity, and environmental effect.

1.3 Preheating and Start-up in Aluminium Smelters: A Critical Foundation for Cell Life and Performance

Preheating and start-up first phases are essential for the operational long life and efficiency of aluminium cells. The cells overall performance and lifespan are influenced by these critical early stages, contributing a considerably 25 % to aspects affecting cell life, a proportion comparable to that of normal operation and exceeding the impact of materials (10 %), construction (20 %), and design (20 %). The sole purpose of preheating is to cautiously and gradually prepare the cathode, ensuring a steady temperature to avoid damages before the addition of molten bath. Numerous approaches of starting cells have been used over time, some early methods with no preheat, but using preheat has been more reliable, successful and remains the prime method today. Throughout these complex stages of cell preparation, energisation, preheating, start-up, and early life operation strict control over voltage, temperature, and bath composition is indispensable [3].

- Mohammed Al MUDALLWI, Reduction Technical Superintendent
- Johan Pool, Reduction Start-up Superintendent
- Yousuf Al BALUSHI Operation Superintendent Room A
- Abdullah Al SHEZAWI Operation Superintendent Room A
- Abdullah Al Alawi Services Superintendent

Their technical insight, operational experience, and continuous support played a pivotal role in the successful implementation of the semi-conventional start-up approach. Their efforts not only enhanced start-up performance but also helped establish Sohar Aluminium as a benchmark for innovation and excellence in reduction cell technology.

9. References

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