EGA Experience in Improving Cell Performance with Upgrade of INALUM Sumitomo S170 Technology

Alexander Arkhipov[1], Alexander Mukhanov[2], Ievgen Necheporenko[3], Ilia Dorokhov[4], Dany Lavoie[5], Konstantin Nikandrov[6], Jamal Alhemeiri[7], Abdalla Alzarooni[8], Abdulaziz Sarhan[9], Pablo Navaro[10], Alya Alshamsi[11], Syed Fiaz Ahmed[12], Khaldun M. Badra[13], Ferdy Rahadian[14] and Recky Suharmon[15]

1. Manager – Modelling
2. Lead Engineer – R&D (modelling)
3. Senior Engineer – R&D (modelling)
4. Former Engineer I – R&D (modelling)
5. Manager – Technology Engineering
6. Manager – Pot Control System Development
7. Lead Engineer – R&D (Pot Control System)
8. Vice President – Technology Development & Transfer
9. Senior Manager – Technology Transfer
10. Senior Manager – Smelting R&D
11. Associate Manager - Technology Transfer
12. Former Lead Engineer – R&D (Engineering)

Emirates Global Aluminium (EGA), United Arab Emirates

13. Senior Vice President – Facility Engineering
14. Vice President – Reduction Operational
15. Lead Engineer – Equipment Engineering

PT Indonesia Asahan Aluminium (INALUM), North Sumatra, Indonesia.

Corresponding author: aarkhipov@ega.ae

https://doi.org/10.71659/icsoba2024-al005

Abstract

EGA has extensive experience in brownfield modernisation of its technologies, with D18+ and D20+ cell designs successfully developed to replace the older D18 and CD20/D20 technologies. In December 2020, EGA and INALUM entered into a Technology License Agreement and a Secondment Agreement of EGA's engineers to review and optimise the performance of INALUM S170 Sumitomo technology reduction cells at the Kuala Tanjung smelter, Indonesia. The collaboration aimed to use EGA's expertise to increase metal production of the INALUM smelter. The initial phase involved upgrading of five pilot cells in a boosted section of Potline 1 to operate at an increased amperage of 20 kA above the nominal 195 kA.

This paper focuses on detailed modelling studies, assessing the electrical and heat balance, magnetic field, MHD, and cathode lining and potshell. It also covers engineering work to modify the superstructure for conversion from centre-break feeding to point feeding and the implementation of EGA's proprietary PLC based cell control system. The studies led to recommendations for improved lining and potshell designs, a superstructure with a new feeding system, and minor busbar modifications aimed at amperage increase while reducing specific energy consumption (SEC). Extensive modelling and engineering studies were required to design the pilot boosted section. The enhancements in design and cell control logic were pivotal in achieving the project KPIs. The pilot cells at an amperage of 215 kA exceeded a daily metal production target by 22 kg per cell, while lowering SEC by at least 0.5 kW/kg Al. The proposed design changes can be implemented on a live potline by shutting down a small group of cells at a time, thus minimizing metal production loss during construction. This paper provides insights into the methodologies and challenges encountered in the design improvement process, contributing to the successful commissioning and operation of the upgraded cells.

Keywords: Cell design, Cell technology upgrade, Mathematical modelling, Engineering, Pot control system.

1. Introduction

PT Indonesia Asahan Aluminium, INALUM, is the largest aluminium producer in the Republic of Indonesia and is a 100 % state-owned enterprise since 2013. INALUM smelter was established in 1976 with Sumitomo cell technology S170. The cell technology in potlines 1 and 3, operating at 195 kA now, has not undergone any major modifications since the startup, except for the lining design. The technology has the following features:

- 2 end anode risers,
- 18 anodes and 16 graphitized cathode blocks,
- Centre-break feeding system,
- Alesa Blue Box Pot Control System (PCS).

INALUM aims to increase production from 250 kt/a to 300 kt/a. INALUM and EGA agreed to conduct a CAPEX competitive feasibility study incorporating minimum cell redesign to increase production of Potlines 1 and 3 to achieve the target production. A Technology License Agreement was signed on 21 December 2020 for the optimise of INALUM reduction cells. More details about the project are given in [1]. EGA has over 30 years of experience in smelter modernisation of its earlier technologies by developing D18, D18+ [2, 3], D20 and D20+ [4] cell technologies. INALUM pilot project marks its first experience of brownfield optimization outside the UAE.

The scope of the study was to increase production from 250 kt/a to 300 kt/a, and to reduce SEC without major busbar modification. This requires amperage increase to 215 kA in Potlines 1 and 3. The study included the addition of EGA's proprietary Pot Control System (PCS) upgrade.

2. Methodology

Using its extensive experience in major and minor brownfield upgrades of old aluminium reduction cell technologies [2-4], EGA followed the following steps for INALUM S-170 cell optimise:

1. Started with site investigation, visual observations of cells, measurement tools inspection and data collection to prepare a detailed analysis. This stage was essential to get a first impression of the technology, understand INALUM operation and measurement procedures and identify the differences in data collection methods to complement the process using EGA-designed tools and methodology. Determining correct measurements is imperative to ensure that cell design and process parameters are well evaluated. Daily performance data was collected for 10 cells for the period from the 1st of August 2020 to the 31st of January 2021 to get an understanding of typical cell performance.
2. Followed by a detailed analysis to check the feasibility of achieving INALUM objective of modernisation. EGA specified in detail design changes and the expected results, based on experience and modelling of cell heat and voltage balance [5].
3. Mathematical models were prepared from the drawings and process data available.
4. During the second visit to INALUM a detailed design validation campaign of the original S-170 cells was carried out for model validation.
5. Detailed cell modelling, engineering, and PCS study was made for possible improvements.
6. A design implementation program was issued for five pilot cells connected to a booster.
7. The plan for start-up, operation and normalisation of the pilot cells, was followed by a detailed performance review to confirm target KPIs.

8. References

1. Sajid Hussain et al., Successful implementation of INALUM pilot cells using EGA cell-upgrade technological know-how, *Proceedings of 42nd International Conference of ICSOBA*, Lyon, France, 27-31 October 2024.
2. Alexander Arkhipov et al., Modelling and Engineering Experience of EGA in Brown Field Modernization of Aluminium Smelters, *Proceedings of 34st International Conference of ICSOBA*, 3–6 October 2016, Quebec, Canada, *TRAVAUX* 45, 831–845.
3. Daniel Whitfield, Sergey Akhmetov, Jose Blasques, and Harishchandra Devadiga, Implementation of D18+ cell technology at EGA's Jebel Ali smelter, Light Metals 2017, 749-757.
4. Ali Alzarouni et al., EGA New D20+ technology with reduced energy consumption, *Light Metals* 2018*, 746-752.*
5. Abdalla Al Zarouni et al., Energy and mass balance in DX+ cells during amperage increase, *Proceedings of 31st International Conference of ICSOBA and 19th International Conference "Aluminium Siberia"*, 4–6 September 2013, Krasnoyarsk, Russia, *TRAVAUX* 42, 494–499.
6. Abdalla Zarouni et al., Mathematical model validation of aluminium electrolysis cells at DUBAL, *Light Metals* 2013, 597-602.
7. Vinko Potocnik et al., Measurement of DC busbar currents in aluminium smelters, *Proceedings of the 35th International ICSOBA Conference,* Hamburg, Germany, 2-5 October, 2017, Travaux 46.
8. Alexander Arkhipov et al., Review of thermal and electrical modelling and validation approaches for anode design in aluminium reduction cells, *Proceedings of the 36th International ICSOBA Conference,* Belem, Brazil, 29 October - 1 November 2018.
9. Valdis Bojarevics al., Mathematical modelling of Hall-Héroult pot instability and verification by measurements of anode current distribution, *Light Metals* 2015*,* 783-788.
10. Ievgen Necheporenko et al., Modelling of the magnetic field and magnetohydrodynamic behaviour of a typical aluminium cell using COMSOL, *COMSOL online conference, 2020.* https://www.comsol.com/paper/magnetic-field-and-magnetohydrodynamic-behavior-of-a-typical-aluminum-cell-model-94921.
11. Sajid Hussain, INALUM pilot pots retrofit using EGA upgraded technology, *Gulf Aluminium Council (GAC) Electrolysis Seminar*, virtual, 28 February 2024.
12. Daniel Witfield et al., Update on the development of D18 cell technology at DUBAL, *Light Metals* 2012*,* 727-731.