STARprobe™ Implementation in Sohar Aluminium Potline

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Abstract

Thermal regulation of aluminium reduction cells is essential for overall potline stability, cell performance and optimum metal productivity. It is currently difficult to instantly know the exact and complete status of a cell. Thermal regulation of cells is achieved by maintaining cell bath temperature and acidity near targeted set-point values. Therefore, any potline will always be looking for technology that provides better thermal regulation with more reliable and quicker results. The STARprobe™ has been adopted by Sohar Aluminium to measure all critical real-time information necessary for optimal cell control and effective thermal regulation.

Sohar Aluminium LLC is a pioneering greenfield aluminium smelter and a frontrunner in Oman's manufacturing sector. This paper will examine the successful STARprobe™ implementation in Sohar Aluminium by critically analysing the cell thermal behaviour, comparison of best practices integrated with ALPSYS thermal regulation, which has been recognised for achieving benchmark results. This report will present the experience of Sohar Aluminium in improving its thermal potline control by changing measurements and analysis methods from classical to modern technology through the STARprobe™ implementation.

Keywords: Aluminium reduction cells, Thermal regulation, Cell bath temperature and acidity, Classical method of cell control, STARprobe™.

1. Introduction

The Sohar Aluminium plant is operating a single potline of 360 cells, AP40 design, with a potential total metal production of 395 000 tonnes per year. It also has a carbon plant producing baked anodes and a cast house to cast the molten aluminium into final ingots and sows' format. Sohar Aluminium facilities include a smelter that utilizes advanced technology and employs best practices along with a dedicated power plant and port facility.

Sohar Aluminium has helped to establish and supply four downstream partners, of which three are currently in operation. Sohar Aluminium has its own state-of-the-art 1 000 MW power plant and a dedicated port facility situated in the Sohar Industrial Port area. Sohar Aluminium, Oman's sole aluminium smelter, aims to set a standard for comparable sectors and contribute to the nation's sustainable growth.

Modern primary aluminium production is based on the Hall-Héroult process. Many factors contribute to the behaviour of modern cells. Some parameters are defined by the cell design (cell lining thermal insulation, maximum amperage capacity, magnetohydrodynamic condition), while others are controlled automatically by a computerized-algorithm system like "ALPSYS" (cell resistance, alumina feeding, regulations), and still others are dependent on human interaction, or operations (anode changing, anode covering, bath corrections, metal tapping). Any incremental process improvement in industrial production might have a significant impact on energy consumption [1].

Currently, the thermal equilibrium of aluminium reduction cells is becoming increasingly constrained as operating current and energy-saving requirements increase, and anode-cathode distance (ACD) decreases. Therefore, fine-tuning the cell thermal balance is crucial and requires a more precise understanding, control, and prediction of the cell mass and energy balance, i.e., process control. Cell thermal equilibrium primarily entails sustaining a stable bath temperature, an appropriate superheat range, a solid ledge, etc. The cell heat equilibrium is the most important factor in maintaining its high efficiency, low energy consumption and prolonging cell life [2].

The temperature and composition of the bath must be controlled to ensure the process stability and efficiency. The basic criteria for regulating the composition and temperature of the bath are the excess AlF_3 in the bath, the bath temperature, the age of the cell, and cell operation. The addition of alumina had the most energy-intensive influence on electrolyte temperature. Alumina feeding caused a significant but temporary drop in electrolyte temperature and superheat. The superheat is critical for alumina dissolution in the bath and affects cell stability. So, precise, on-time, and consistent feedback on cell variables is critical for making control decisions.

While cell parameters such as bath temperature and excess AlF_3 must be measured manually on a regular basis, critical parameters such as superheat and free alumina are estimated or measured less frequently. These are the critical inputs for cell temperature regulation, and they necessitate the best industry sampling processes, process control experience, and standards [3,4].

Sohar Aluminium introduced an innovative bath chemistry measurement technology via STARprobe^{TM}, which provides simultaneous measurements of five cryolitic bath characteristics. The STARprobe^{TM}, which stands for Superheat, Temperature, Alumina concentration, and Ratio (STAR) analysis equipment, delivers real-time results that enable improvements on process control management.

In this paper we will cover the Sohar Aluminium experience in the implementation of the new measurement system and how the new thermal regulation methodology improved the cell performance and efficiency. The Sohar Aluminium trial approach was designed to gradually introduce new procedures, hence limiting potline disruption.

2. Conventional Measurement Method and Challenges in Process Control

The goal for the potline is to maintain stable cell conditions during normal operation. Maintaining a consistent bath temperature, an appropriate superheat range, a decent ledge, etc., are all aspects of cell heat balance that require careful attention during operation. Numerous studies have demonstrated the importance of heat balance in ensuring the cell continues to function at optimal efficiency while using as little energy as possible [5].

We also ran into challenges with operational practice for properly employing the probe, as the excessive dipping of the probe tip resulted in many damaged probes during the early stage of the installation. We were able to consistently obtain roughly 80 dips per tip by monitoring shifts and providing rigorous refresher training sessions for the operators to make them more familiar with standard practice and monitor their work for compliance.

In order to effectively accommodate the work schedule in the measurement group, it was also one of the most important requirements that each group measurement be finished in under 2.5 hours. This will give you enough time to adjust the cell parameters for optimal cell performance, allowing you to optimize the cell before the following period.

11. Conclusion

Sohar Aluminium Smelter's adoption of the STARprobe™ was a technical and productivity success story. The potline performance has been boosted to its present benchmark level with the aid of the STARprobe™ assistance in enhancing the thermal regulation system as an enabler, and this improvement in thermal management can be further refined.

Measurement precision and reliability can only be achieved by strictly adhering to the STARprobe™ outlined principles and procedures. Paying close attention to these rules and principles will increase the likelihood that the promised advantages will be attainable. The interface of the STARprobe™ with thermal regulation was formed, and these new insights improve thermal regulation potential to be successful, resulting in a stable thermal balance of the cells. Reduction in the variation of the deviations of the operating parameters from the target values resulted in thermal stability, a decent side ledge thickness, and more stable AlF_3 feed shots.

Measuring superheat and alumina content in bath helps process engineers to determine preventive action, such as regulating the resistance target, optimizing the AlF_3 shots, or adjusting the bath in the cell. STARprobe™ delivers reliable bath chemistry and superheat for preventative process control of the cells, thus improving regulation of the cells and productivity.

Further improvements were forecast prior to implementation and validated through pilot tests. These improvements were accomplished through increased cell performance, less use of AlF_3, and decreased exposure of humans to the process.

12. References

1. Vanderlei Gusberti et al., Modelling the aluminium smelting cell mass and energy balance – a tool based on the 1st law of thermodynamics, *10th Australasian Aluminium Smelting Technology Conference*, 09 – 14 October 2011.
2. Tormod Drengstig, *On process model representation and AlF_3 dynamics of aluminum electrolysis cells*, PhD Thesis, NTNU, Trondheim, Norway, 1997.
3. Haris Salihagić Hrenko and Jožef Medved, Managing the electrolysis process by integrating in situ measurements of the bath's properties. *JOM* 70, 2018, 1883-1886
4. Marc Dupuis, Bath ratio and temperature control enhancement in the potroom, *Light Metal Age*, February 2013, 20-21.
5. Jiaming Zhu and Jie Li, Transient simulation of bath temperature inside aluminum reduction cells, *Metals* 2020, 10(3), 379.
6. J. Thonstad et al., The dissolution of alumina in cryolite melts, *Essential Readings in Light Metals*, 2016, 105-111, https://doi.org/10.1007/978-3-319-48156-2_14.
7. Zeng Shuiping, Wang Shasha and Qu Yaxing, Control of temperature and aluminum fluoride concentration based on model prediction in aluminum electrolysis, *Advances in Materials Science and Engineering*, vol. 2014, 5 pages.