Anode Setting Pattern Changes in Sohar Potline Operation

Agnello Borim[1], Javier Navia[2], Said Al Hinai[3], Abdullah Al Dhahli[4], Roa Al Shezawi[5], Mohammed Al Mudallwi[6] and Yousif Al Balushi[7]

1.Chief Operating Officer
2. Plant Operations Director
3. Reduction Operation Manager
4. Potline Technical Superintendent
5. Potline Lead Engineer
6. Potline Superintendent
7. Potline Superintendent
Sohar Aluminium Company L.L.C, Sohar, Sultanate of Oman
Corresponding author: abdullah.aldhahli@sohar-aluminium.com

Abstract

In modern aluminium reduction prebaked cell technology, anode changing is the highest disturbance to cell performance in many aspects, including thermal balance, anode current distribution, and the electric current flow. In the extreme, pot instability can occur and energy consumption may increase. Selecting the optimum anode changing sequence or pattern is essential to optimize the thermal balance, anode covering practices, and energy consumption for the individual cells. This results in optimized operational practices such as the optimized covering material, minimum anode incidents and metal purity. In this paper we present the Sohar Aluminium smelter experience and transition strategy in converting the operating anode change sequence from the butterfly pattern to the typewriter pattern. Also, the potential gains of pot and potline performance are shown.

Keywords: Aluminium reduction cells, Anode changing patterns, Butterfly anode changing pattern, Typewriter anode changing pattern, Cell performance.

1. Introduction

The Sohar Aluminium (SA) plant is operating a single 360 pots AP40 design, with a potential total metal production of 395 000 tons per year, a carbon plant producing baked anodes and a casthouse to cast the molten aluminium into final P1020 products of ingots and sow's format. In addition, the plant has its own 1 000 MW power plant, a substation with 5 rectifiers, each rated at 103 kA and a port terminal.

Aluminium smelters using prebaked anodes technology are the most common nowadays. As a continuous process environment, main operations are on repetitive cycle mode, for 32 hours cycle operation for Sohar Aluminium case. Each operation is a disturbance to the pot operation, but they are essential to the smelting operation as a continuous production process.

Different technologies are competing on how to reduce the impact of the essential operations disturbances such as: optimization work on the magnetic field and busbar design, simplified operations and cell design. Meanwhile the operating smelters management are focusing on optimizing those operation to obtain better current efficiency and reducing the energy and other specific consumption with respect to the technical basic data list (BDL) provided by the technology supplier. Any smelter has the continuous improvement challenge and the drive to optimize how to operate to obtain the optimum results to meet the BDL itself or better than the BDL expectations.

Sohar Aluminium smelter initiated a review of the anode change cycle or pattern targeting to achieve benchmark results, promoting continuous improvement through lean six sigma approach and statistical analysis.

The anode change operation is the most disturbing operation to the aluminum cell and any change in the standard procedure will have a direct impact on cell performance itself, positively or negatively. Thus, any change to this operation will have to be established or performed after a robust validation process.

The anode change operation has a direct impact on pot's thermal balance, electric current flow, heat dissipation and overall current efficiency performance. In continuous smelter operation, the challenge remains in all technologies at every new anode change by considering the neighbouring and the oldest anodes behaviour, the anode position to the metal velocity pattern, cold anode offset and resistance compensation, anode energization power and the magnetic field impact at individual anode location [1].

In this paper we will cover the Sohar Aluminium experience in the migration to the typewriter pattern and how the new sequence improved the quality in the operation and the pot performance.

2. Anode Sequence Optimization Elements

Triggering the need to optimize the anode cycle at any plant is often dependent on how passionate the organization is to further improve how they operate, moving away from their comfort zone. In addition, the pot might have a performance limitation to accept a further lower ACD operating zone, as required during planned amperage increase. Efforts need to be consistently made to optimize key parameters such as bath power, internal heat, instability level. superheat, etc., in order to facilitate the amperage ramping up progress.

To improve pot performance, it is required to have robust and consistent operation standards, along with discipline in the execution, so the human factor will not distract our analysis and conclusions.

Figure 1 chart illustrate the different stages to be covered during the process. It is very important to model and simulate the alternatives before piloting, avoiding multiple tests as these are difficult to manage and to coordinate/integrate with normal operation. Also, it takes longer time with less efficient comparison. Optimization opportunities are reduced, considering the normal potline life with a dynamic event and variability sources including material, pot life, amperage setpoint, ambient and climate changes and other external factors.

A short list of only 2 options for the pilot test were selected, for better optimization opportunities, hence better visibility to reach the optimum solution. It is essential to have a statistically representative sample for each pilot model.

Moreover, the optimized covering practice and quality enables the team to have a better control on the material and reduces the basement spillages. So, this optimization was projecting a potential 30–40 % reduction of people effort and overall equipment exposure, including the whole bath circuit equipment and conveying system, pot tending assembly cranes (PTAs), cover mix filling station and basement cleaning machines.

8. Main Challenges Faced and Lesson Learnt

An anode change cycle conversion project is one of most challenging projects as it has direct impact in one of the main potline operations and the highest disturbance in the cell performance. Thus, it requires a strong and brave leadership decision to go with the change. This type of project requires a massive team effort. Also, it requires a proper piloting technique to support the team to optimize the effort needed throughout the transition journey. Therefore, empowering and pushing the team spirit and motivation is an essential measure to the project success. Another big challenge is the implementation and quick adaptation of the new/revised operational practices.

9. Conclusions

The anode change pattern project was a successful story at Sohar Aluminium Smelter towards a technical and better productivity performance, which was considered as one of the enablers to the current benchmark and outstanding performance among other projects conducted over the last three years.

Changing the anode pattern in a running potline is not an easy decision, as it requires a strong confidence base in all levels of the organization, in which Sohar Aluminium management team worked strongly to establish throughout the past years. In addition, handling such project in a modern young smelter without the need to an external consultant or even external resources in implementing the change confirms the maturity of the organization in all different levels.

10. References

1. Vanderlei Gusberti et al., Modeling the effect of the anode change sequence with a non-linear. *Light Metals* 2007, 317-322.
2. H. Sun, Oleg Zikanov and Bruce Finlayson, Effect of background melt flow and interface distortion on the stability of Hall-Héroult cells, *Magnitnaya Gidrodinamika* 41, 2005, 273-287.
3. Hasini Wijayaratne et al., Effects of composition and granulometry on thermal conductivity of anode cover materials, *Light Metals* 2011, 399-404.
4. Mark P. Taylor, Anode cover material – science, practice and future needs, *Ninth Australasian Aluminium Smelting Technology Conference and Workshops*, Terrigal, Australia, 4 – 9 November 2007, Paper 11.