Challenges of Prolonging Life of Aged Anode Baking Furnace-1 at Aluminum Bahrain (ALBA)

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Abstract

Anode baking process is the most critical step in anode production. It has strong influence on anode quality in terms of baking level, heating-up rate, physical defects such as cracks or air burn and affects performance of anodes in electrolysis cells. Therefore, it is utmost priority to have good baking process control and operation. In addition, the anode baking furnace capacity is usually the bottleneck of increasing anode production without compromising anode quality. To increase bake anode production, anode baking furnace is to be operate at faster fire cycle compared to design value which required process optimization and no tolerance on process deviations. This paper shares the experiences of sustaining, improving the condition and performance of Anode Baking Furnace #1 (ABF#1) at Aluminum Bahrain (ALBA). ABF#1 is the oldest furnace in ALBA, having 51-year-old concrete casing and 26-year-old headwall/insulation. Due to thermal and mechanical stresses during the baking process and high age of ABF#1, the integrity of the concrete casing is affected, resulting in high headwall deformations which pose many challenges in operation, process and flue wall maintenance. The technical challenges encounters in process, operation, maintenance and innovative solutions implemented to sustain and improve the furnace condition, productivity and environment is further discussed. The paper also outlines the impact of flue wall condition on the fume treatment plant (FTP) operation and anode baking process and quality.

Keywords: Anode baking furnace, Corbel, Concrete casing, Headwall, insulation, Anode quality.

1. Introduction

Aluminum Bahrain (ALBA) is the world's largest single-site aluminum smelter ex-China with an aluminum production of more than 1.56 million t/year (2021) is known for its technological strength and innovative strategies. ALBA is always striving to maximize the productivity and reduce consumption of resources to continuously reduce impact on environment, improve safety and overall business. Hand in hand with continuous increase in metal production in the potline, the carbon plant has also been increasing the production and improving bake anode quality. ALBA has got four paste plants, five baking furnaces and four rodding plants to cater the anode requirement in terms of quality and quantity to Potline 1-6.

Several papers have been published on anode quality and what defines good performance in the potline. The anode quality is defined by low variation, low CO_2 and air reactivity, low air permeability, low electrical resistivity, low metallic impurity levels and high density [1][2]. Anode baking is one of the critical steps of anode production, which has significant influence to achieve better and consistent anode quality (such as density/reactivity).

The anode baking furnace (ABF) is where the anodes are heat-treated to calcine the pitch binder and to develop the desired anode quality for use in the potlines. ABF is made up of high quality refractory materials. It consists of a series of parallel flue walls in which the gas is injected to get desired temperature. The space between flue walls is called pits, where the anodes are placed during heat treatment. A group of adjacent pits is called section. Each section is separated from the next by a headwall.

Anode baking furnace #1 (ABF#1) is the oldest anode baking furnace among all five baking furnaces at ALBA. It supplies baked anodes to Potline 1-3 and has a production capacity of 92500 t/year. It was originally a closed-type furnace, built in 1971. It was converted to an open-type furnace in 1996. It consists of 50 sections, with 5 pits and 6 refractory flue walls in each section. Headwall expansion gaps are located in the middle of the pit. It has three fire groups equipped with Innovatherm firing control system. Each fire group consists of eight numbers of ramps including three numbers of burner ramps, one fume measuring ramp, one zero pressure measurement ramp, one exhaust ramp, one blowing ramp and one cooling ramp.

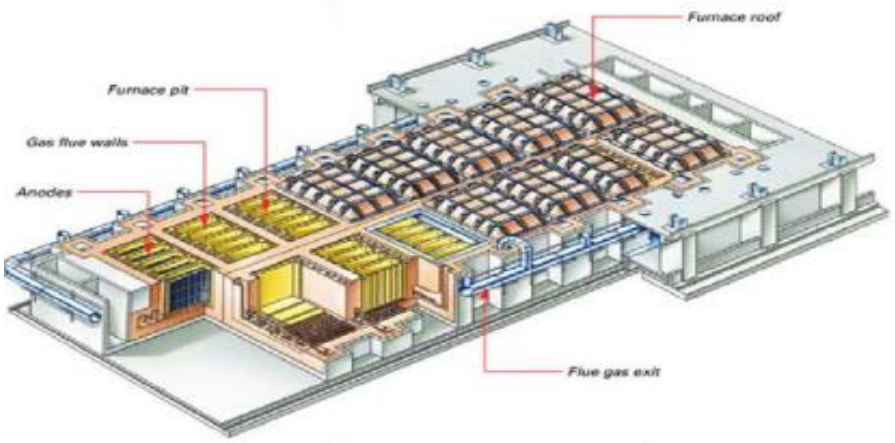

Figure 1. Original closed type technology of ABF#1.

While ABF#1 was converted from a closed-type (Figure 1), to an open-type ring main furnace, the original concrete casing/tub was repaired and modified to a single central ventilated wall configuration. Sixteen more sections were added to the existing furnace by extending on both ends of the furnace (north and south end side).

Anode baking is the most expensive process step in anode production. Fuel and refractory maintenance represent approximately 15 % of total anode manufacturing cost The condition of ABF plays a key role in maintaining good baking process and low anode rejection (< 0.5 %). A good ABF ensures tar/soot free baking process by sustaining the required draft and a uniform temperature distribution inside the flue wall (± 50 °C). The quality of Anodes used in the potline depends strongly on baking process. It is require to achieve uniform temperature inside the anode during heating process. The flue walls in ABF deform over a time under cyclic heating and cooling process, leading to difficulties in loading and unloading of anodes, and inconsistent of anode heat treatment. It is important to regularly measure the deformation to assess the rate of deterioration and prediction of flue wall life. The aging of ABF, and the deformation of flue walls and headwalls results in non-homogeneous heat treatment of anodes and consequently to a deterioration of anode quality [3][4].

Refractory linings of ABF suffer severe corrosion during operation. The service life is therefore in relation to the construction of the flue channels and walls, operation procedures of the loading

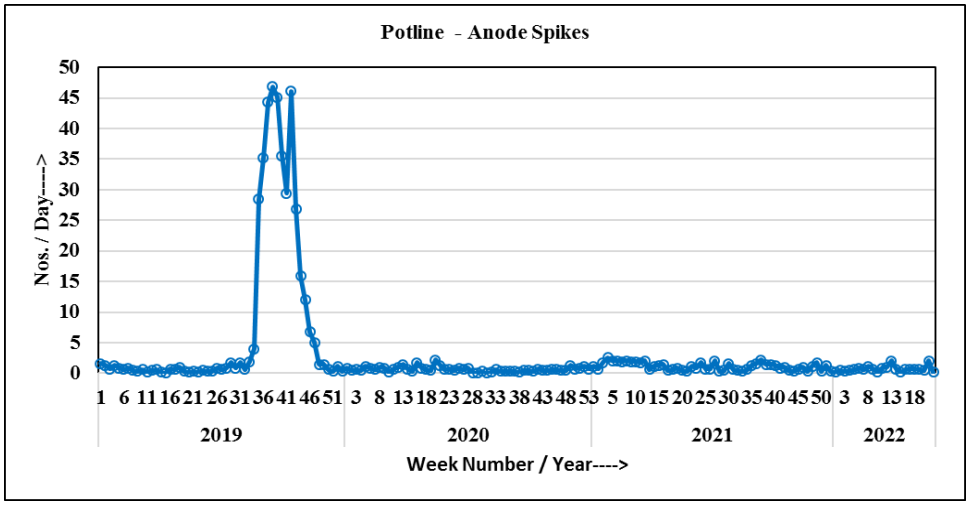

Figure 18. Anode spike trend in potline.

6. Conclusion

The performance of anode baking furnace # 1 has been deteriorating over time during its over 20 years of operation. During 2019, it became a challenge to sustain the baking process and production. The poor condition of the furnace in terms of headwall deflection, flue wall deformations, damaged corbel and damaged concrete casing resulted in significant reduction in anode quality. Bad baking process further resulted in risk of fire, poor anode quality and an increased number of anode related incidents in the potline.

ALBA team has analyzed process data along with physical audit of refractory condition to identify the issues in Anode baking furnace. A maintenance plan was implemented on the anode baking furnace to restore the refractory condition. Continual Process optimization carried out with improved refractory condition to bring the furnace back to producing well performing anodes. This has enabled ALBA to delay a full anode baking furnace revamping by more than 5 years.

7. References

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