Major reconstruction of central casing of open top baking furnace with a view to increase its lifespan and reduce the total costs comparing to full reconstruction

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Abstract

Anode baking furnace (ABF) is fundamental for the production of anodes with specifications and quality suitable for aluminum electrolysis. The anode baking furnace shell inside whom the refractory is installed is usually called “casing” or “tub” and is made out of various concrete elements. The casing is a critical component of the facility and usually faces very few modifications during its lifetime due to the magnitude and complexity of the work and therefore its impact on production capacity. Aluminium of Greece (AoG) operates with success its anode baking furnace since its start up, more than five decades ago. Thermal and mechanical stresses created by the baking process however affected the integrity of the concrete casing in the central part. Distortions, deformations and cracks were indeed visible in comparison to the outside part of the casing. This paper goes through the different phases undertaken by Aluminium of Greece in order to successfully develop and safely realize a major repair on its casing while limiting costs and impacts on production and anode inventory. The scope of work was indeed composed of the replacement of the casing walls in the central passage as well as the anode conveyor supporting structure with a limited impact on the refractory (insulation, headwalls and fluewalls). The article details the technical challenges and innovative solutions as well as the project and operation organization put in place in order to realize the work without any safety incident and in a strict schedule of ninety days. Finally, the start-up and ramp-up phases realized by Aluminium of Greece operation team in order to successfully manage old and new sections and bring back the furnace at steady production in a minimum time are detailed.

Keywords: anode baking furnace revamping, concrete casing, casing walls, headwalls, fluewalls.

1. Introduction

Anode Baking Furnaces (ABF) are fundamental for giving the anode its most significant properties, such as electrical and thermal conductivity, air and CO_2 reactivity, mechanical strength etc. To do so, green anodes are fed into pits and heated up to 1150°C. The main parts of the Baking Furnace consist of the concrete casing (composed of the casing walls and raft) and the refractory bricks for the thermal insulation and the headwalls and fluewalls.

AoG anode baking furnace is an open top ring type furnace designed by Aluminium Pechiney and erected in the 1970, Figure . It is composed of 78 sections with 6 pits per section (i.e. 7 flue walls). Four fires are operated at 26h cycle for a total output of approximately 93.000mt of baked anodes/year.

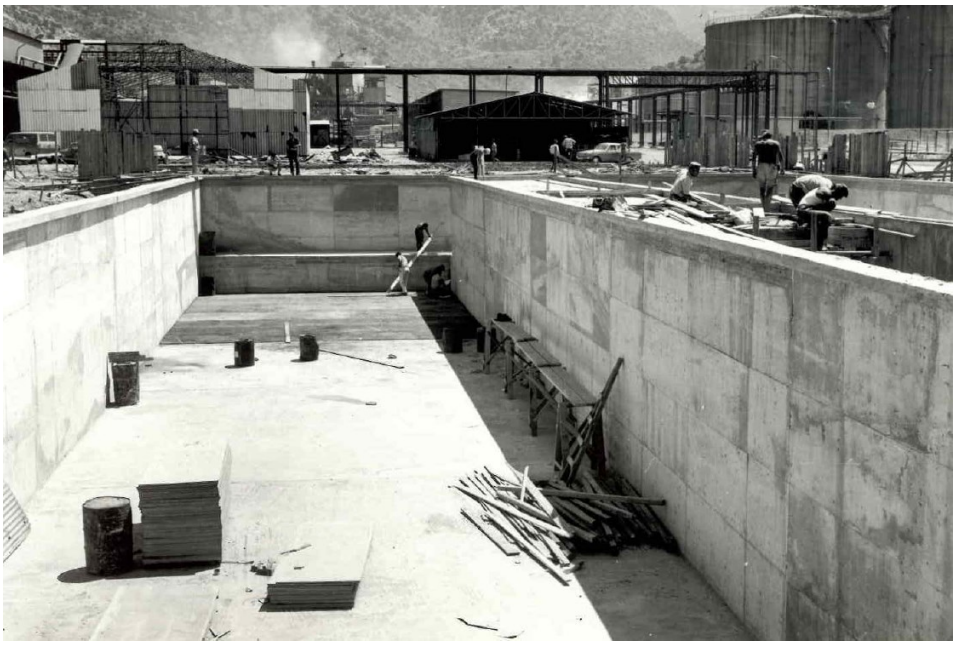

Figure 1. Aluminium of Greece concrete casing during furnace construction (1970)

After more than five decades of thermal and mechanical stresses due to continuous operation, concrete elements of AoG baking furnace display distortions, deformations and cracks. These defects are mostly observed under the central anode's conveyor where green and baked anodes are distributed in and out of the anode baking furnace. As they are supported by soil (AoG baking furnace casing is built underground), side concrete elements are indeed in a much better condition than the stand-alone civil elements in the central. Contrary to refractory and insulation wear (replacement or partial repair of headwalls, fluewalls, insulating walls etc.), concrete casing defects can hardly be fixed through daily maintenance routine and ultimately affect the anode baking furnace safety and operation. Defects with a magnitude of the ones observed on AoG furnace are usually managed with a full reconstruction project involving important financial resources.

This paper presents the different phases undertaken to successfully develop and realize a breakthrough project of partial reconstruction of AoG anode baking furnace concrete elements (central parts only) and their nearby refractories and insulation in ninety days. A tight and very carefully designed time schedule for every reconstruction phase allowed to minimize cost and production losses. Technical and administrative challenges will be reviewed in detail as well as the shut down and, after ninety days, the simultaneous start-up of the four fire groups. In particular, the strategy adopted in order to properly manage the moisture released from the new refractories will be discussed. Finally, the paper concludes with a summary of the benefits of this project.

2. Main causes ABF Revamping need at AoG

Through the decades and due to continuous mechanical and thermal stresses, the concrete casing of the baking furnace moved towards the center. As a result, the upper part of the central vertical casing walls eventually came in contact with the concrete slab and the foundation of the central

The refractory installation has been realized in 30 days with the installation of 78 external fluewalls, headwalls extremities, insulating floor and insulating walls. The main challenge was the large number of workers needed at the same time in a tight environment in order to install the refractory. This has been successfully managed by AoG project team through a very strict scheduling of activities as well as a continuous awareness of the workers about the coactivity risks.

Connections between old and new parts for the insulation and the headwalls was successfully managed by AoG bricklayers thanks to their strong experience, Figure 13. As new and wider insulating walls were installed, the position of the 6th fluewall has been adjusted in order to achieve a proper pit width.

Figure 13. Headwall reconstruction around old fluewalls

4.3. Furnace restart

The four fire groups were restarted simultaneously. Moreover, and due to the fact that 1/6th of the ABF was now new, it was necessary to design two different start up procedures for every fire. The new pits (pit #6) were indeed loaded with baked anodes and specific curves were applied in order to realize a proper dry-out. The other pits were loaded with green anodes.

5. Conclusion

For the first time a successful partial reconstruction of an ABF is reported. The main challenge tackled by AOG engineers was to reconstruct only the heavily stressed central casing elements with as less impacts as possible on the refractories (insulation, headwalls and fluewalls).

The strong preparation and execution follow-up realized by AoG allied with the technical expertise of Rio Tinto – AP allows to successfully realize the project in ninety days and achieve the main noteworthy results:

- Safety excellence (zero medical treatment cases, zero lost time injuries);
- Cost avoidance (compared to a full reconstruction solution);
- Minimum production losses;
- ABF Lifespan extension (given that the rest of the ABF structural elements are in fairly good condition).