New Generation Anode Baking Furnace: a Breakthrough Technology Increasing Productivity and Sustainability

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Abstract

The anodes used for aluminium production are baked in order to reach the resistivity, mechanical resistance and reactivity adequate for the electrolysis process. The anodes are baked in pits that are usually separated from each other by fluewalls and headwalls made of dense refractory material. In 2017, an industrial prototype of the new generation anode baking technology was installed at the Bell Bay smelter with 6 sections converted to this patented technology. The headwalls were partially removed to allow a productivity increase by 15 % and gas consumption reduction by 30 %. The operation and maintenance of this breakthrough technology has raised some challenges which have been overcome with the development of new tools and operation/maintenance procedures, as well as some design improvements that have been implemented during the rebuild of this zone in 2021, after 82 rounds of fire. As a second and a third zone are planned to be built on the Bell Bay furnace in 2022, this paper reviews the exceptional performance of the first industrial prototype, as well as the issues and challenges related to the deployment of this technology on a complete furnace.

Keywords: Anodes in aluminium electrolysis, New Generation anode baking furnace, Rio Tinto Bell Bay.

1. Introduction

In an open-type Anode Baking Furnace (ABF), anodes are placed in pits separated by hollow fluewalls, through which hot gases flow during the baking phase and air flows during the cooling phase. Sections are separated by headwalls through which flue walls in the same row are linked between one section and the next, thereby forming individual flue wall lines extending along the entire furnace.

The headwalls constitute 20 to 25 % of the dense refractory mass installed in the furnace. They are heated and cooled during each fire cycle, which requires a large amount of gas and limits the ability to rapidly cool the anodes. The sealings between the fluewalls and the headwalls need regular maintenance, during which refractory maintenance operators enter the confined space of the pits and renew the fibers under difficult conditions: high temperature, working at height, presence of dust and fibers. Based on those considerations, a concept of New Generation (NG) anode baking furnace was proposed [1, 2].

After several developments and the installation of a pilot zone in one of the furnaces at Grande-Baie plant, the implementation of this technology on six sections of the Bell Bay Aluminium (BBA) furnace was realized in 2017 [3].

The purpose of this article is to review the performance of the first generation of the New Generation design implemented in BBA after nearly five years of operation and to detail the improvements integrated in the current and future works.

2. New Generation Anode Baking Furnace concept

2.1 Concept of the New Generation (NG) Technology

The concept of the NG patented technology [1, 2] is to remove totally or partially the headwalls as presented in Figure 1. It is applicable to both furnace revamping and new projects. For existing furnaces, it allows to increase the volume available for anode baking inside the pits. The number of headwalls to be removed should be selected depending on the anode dimensions to accommodate either an extra set of anodes or an increase in anode dimensions.

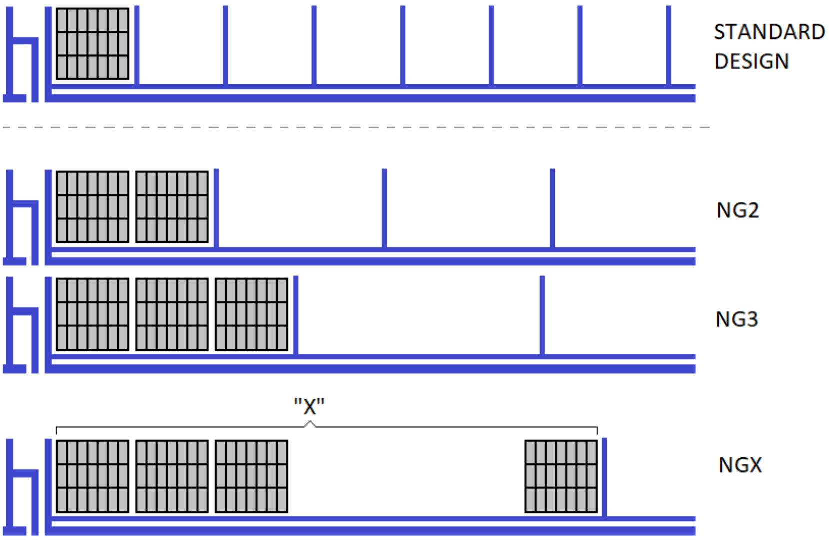

Figure 1. Concept of the New Generation Technology.

2.2 Headwall functionalities and challenges with their removal

The key role of the headwalls in the standard ABFs is the following:

- Allow for thermal expansion of the fluewalls
- Mechanically support fluewalls when pits are empty
- Separate sections (delimitation for operation sequence)

As the headwalls are removed in the NG design, it has been necessary to develop technical solutions and to adapt operational practices to assure the above functions. In particular, the NG design should allow the accommodation of the fluewall for thermal expansion which is usually allowed via the expansion gaps located at the junction between the headwall and the fluewalls in the standard design (see upper part of Figure). As headwalls are no longer present, the internal design of the fluewall was modified so that the expansion and contraction can be handled by the fluewall itself through dedicated zones, called “breathing zones” (see lower part of Figure). The design of bricks used in these areas has been modified so that relative movements between bricks is less inhibited in these locations compared with the rest of the fluewall.

4. Conclusion and Perspectives

The overall performance of this first 6-sections wide NG zone was beyond expectations.

Over the lifetime of 82 fire cycles, the NG zone allowed:

- 17 % of productivity increase (+ 8 759 anodes over the lifetime of the zone)
- 14 % reduction of CAPEX
- A gas consumption reduction by 30 % (equivalent of 613 kAUD gas savings)
- 2 654 t CO_2 savings for 1 / 8^{th} of the furnace converted
- 80 % less sealing maintenance

The NG Technology has proven to be an appropriate solution for a productivity increase of existing anode baking furnaces; i.e. in the same furnace casing. It also provides an option for the reduction of the gas consumption/CO_2 emissions. This validates the technical and economic viability of this new breakthrough technology. However, the business case associated to this technology has to be evaluated for each plant (possibility to have an extra set of anodes, plant's need for higher productivity, storage capability, etc.).

As a result of this success, BBA has decided to rebuild the zone with the NG technology in October 2021. It has also decided to extend the NG technology to 5 other NG6 areas on the furnace by 2025. A major step was reached in July 2022 with the prefabrication of the 33 m long fluewalls in 12 lifts/fluewall, which were built in situ in the 2017 and 2021 installations. This represents an opportunity to significantly reduce the construction time, with less production loss.

5. References

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