The Successful Testing and Implementation of AP30 Technology Spinoff Cell Designs at Alcoa Fjarðaál

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Abstract

In April 2007, Alcoa Fjarðaál smelter started its first cell using the Aluminium Pechiney technology AP30 platform, fitted with an Alcoa cell lining design intended for an initial nominal amperage above 300 kA. The AP30 technology was also used at Alcoa Deschambault smelter since 1992, which was at the time the state-of-the-art cell technology. Based on already proven technology solution, supplemented with our fundamental knowledge and experience, Alcoa decided to use the same platform for its Fjarðaál smelter. Since then, the Fjarðaál smelter has tested and deployed different cell designs that have demonstrated excellent performance. The third reline wave has been ongoing since March 2020. Aiming to increase the amperage above 380 kA, Alcoa Fjarðaál initiated a large-scale trial of new cell designs. In addition to already available developments, two new conceptual cell designs were developed targeting specific characteristics of the smelter. Performance tests were carried out on a group of 10 cells using a given design and 20 cells with a different design. Operational performance metrics were statistically compared to the selected reference standard design. This paper presents a description of Alcoa's cell design change governance and a comparison between the different designs.

Keywords: Alcoa Fjarðaál, AP30 technology, Cell design, Load increase, Amperage increase.

1. Introduction

The Alcoa Fjarðaál Aluminium plant started production in 2007, with operation of one potline with a total of 336 cells and nowadays presents a capacity above 340 kt/year. The AP30 technology was chosen for deployment based on the successful operational results demonstrated in Alcoa Aluminerie de Deschambault Canadian smelter that started operation with 264 cells using AP30 Technology in 1992. Since that time this aluminum plant has started more than 1600 cells in the regular operation [1], consequently verifying the process performance as a part of internal line current increase programs including multiple campaigns of special field measurements.

The AP30 line at Fjarðaál has had two relining waves and is presently undertaking its third relining generation with planned testing of two new modified cell designs with the intention of increasing amperage towards 390 kA. Table 1 summarizes the cell design development at Fjarðaál.

Table 1. Summary of Alcoa Fjarðaál plant cell linings generations.

Cell Design AP30	Deployment date	Target nominal load (kA)	Objective	Average cell life	Number of cells
FJA 1st Gen v. 1	April 2007	365-380	Technology transfer	2273	338
FJA 1st Gen v. 2	April 2008	365-380	Amperage increase	2118	2
FJA 2nd Gen v. 1	April 2011	380	Amperage increase	2108	11
FJA 2nd Gen v. 2	July 2012	380	Amperage increase	1724	3
FJA 2nd Gen v. 3	May 2014	380	Amperage increase	2307	443
FJA 2nd Gen v. 4	April 2019	380	Amperage increase	---	28
FJA 3rd Gen v. 1	February 2020	390	Amperage and cell life increase	---	48
FJA 3rd Gen v. 2	September 2020	390	Amperage increase	---	78
FJA 3rd Gen v. 3	July 2021	390	Amperage increase	---	150
FJA 3rd Gen v. 4	October 2021	390	Reduce energy consumption and amperage increase	---	10
FJA 3rd Gen v. 5	December 2021	390	Reduce energy consumption and amperage increase	---	19

The economic strategy used for developing the plan for amperage increase was to increase production through modifications of the cell design and optimization of process control for stable operation at higher amperage. The existing infrastructure capacities of electrolysis, rodding shop, casthouse, alumina distribution systems, available rectifiers, machines, equipment as well as manpower were anticipated to be used as is. Through efforts to improve cell design and operational excellence, Fjarðaál presently operates at a line load of 380 kA and is targeting 390 kA. The main challenge in the creep program is the power availability. This restriction led to higher demands for voltage savings and CE improvement for the new cell design.

Figure 1 presents the evolution of line load versus specific energy consumption at Alcoa Fjarðaál. In October 2010, there was a rapid drop in the current from 377 kA to 365 kA due to fire in a transformer at the substation. The power outage lasted for 2.3 h, but no cells were curtailed [2].

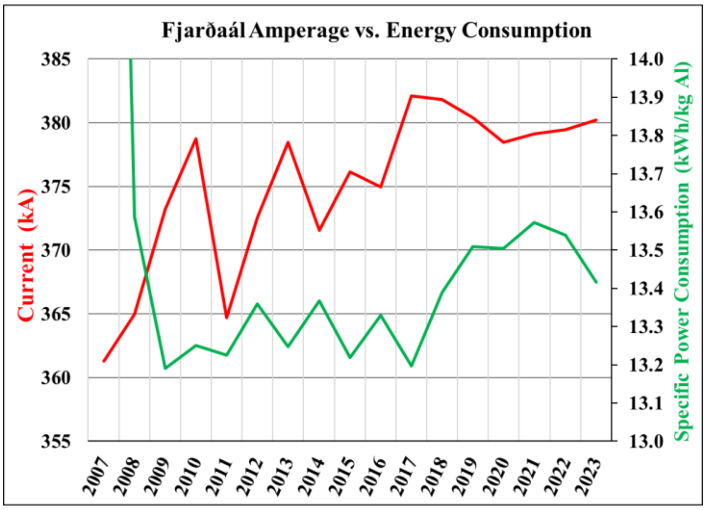

Figure 1. Evolution of line current and specific energy consumption at Alcoa Fjarðaál, per yearly average.

This paper presents operational test results from AP30 spinoff cell designs over two years and key milestones in the development of new cell designs at Alcoa, as defined in our cell design change governance system.

Operating under the assumption that the stability issues seen in TD#1 were primarily due to excessive ridge formation, changes to operational targets were initiated. At first, an increase in the target resistance for TD#1 was applied to both operate the cell with a larger ACD and also to increase the heat generation to help reduce ridging. This did not yield a drastic improvement in reducing the peak number of NOIs detected following periods of high metal levels. After this observation, an increase in the metal level target was made to determine if operating with both a larger ACD and higher metal levels would stabilize the cell. This combination provided a level of stabilization that then enabled small steps in reducing target resistance to be explored as a means of process optimization for this design. However, as seen in Figure 4, it was not possible to lower the resistance enough to be comparable to TD#2 and still operate stably.

While to date these changes appear to have helped reduce the sensitivity of TD#1 to large swings in metal pad levels, this design still suffers from higher levels of instability than TD#2, as seen in the most recent data presented in Figure 5. Test Design #1 still appears to more readily perturbed by the presence of muck or anode problems than Test Design #2. A difficult operational cycle can develop when Test Design #1 is perturbed by the presence of muck. When muck induces higher noise or more frequent NOIs, current efficiency suffers and the ability to properly feed alumina is degraded, making overfeeding and in turn more muck formation likely. To break out of this cycle, manual interventions were at times needed to help stabilize TD#1 cells when it was suspected that muck was the cause of frequent NOIs. Generally, muck was suspected to be the cause of NOIs when no large changes in liquid levels had occurred recently. When muck is present on the cathode, as in the case of excessive riding, it would result in the formation of horizontal current flows and make NOIs more likely to occur.

5. Conclusions

AP30 Technology in Fjarðaál has evolved towards new standard design intended for operation at high amperage. Through dedication of Alcoa technology development experts and combined efforts with plant engineers, the conceptual study simulation modelling for the development of the new test design, installation and start-up, performance test was completed successfully within 3 years' timeframe. In June 2023, it was decided to implement Test Design #2 at Fjarðaál. Test Design #2 is not only superior to Test Design #1, but also more robust than Reference Design #3. Test Design #2 has been proven to run with excellent stability, reduced cell voltage, more over computational analysis predicts its capability to aluminum production beyond targeted 390 kA.

6. References

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