New Connections for Cathode Flexibles in Aluminium Electrolysis Cells

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Abstract

Cathode flexibles are one of the key components in aluminium electrolysis cells design as they provide the continuity of electrical current path from cathode of the cell to the busbar. An efficient cathode flexible design should provide long service life and enable fast cell turnaround time and thereby minimize the plant production losses. Over the last 35 years at Emirates Global Aluminium, the duty of cathode flexibles has become harder due to large amperage increase, which has increased temperature, voltage drop and copper corrosion. To address these issues, a new cathode flexible design has been put in place in EGA cell technologies. Contrary to the traditional cathode flexible design, where the flexibles are welded on cathode busbars and bolted on the cathode collector bars, the newly developed flexibles are welded at the end of the collector bars and bolted at the cathode busbar. This shifts the bolted contact surfaces to a much cooler region, gives easier access for the bolting and allows welding of the flexibles to the collector bars to be done outside of the potroom. In this paper, design, modelling, experimental evaluation and long term operational performance of newly developed connections for cathode flexibles across EGA cell technologies are presented.

Keywords: Cathode flexible design and modelling, bolted joint voltage drop, measurement of cathode flexible voltage drops, copper tab corrosion.

1. Introduction

In Hall-Héroult industrial reduction cells, the DC electrical current is fed into the anodic busbar which flows to the anode beam, to the anode rod, to the carbon anode block and through the liquid electrolyte. Thereafter it crosses the liquid metal pad and eventually is collected at the cathode blocks. Each cathode block is equipped with one or two collector bars, aligned along the length of the cathode blocks, usually made of steel, which are connected to the cathode busbar through flexible connections made of aluminium. Each such flexible connection extends between the end of the cathode collector bar and the upstream (US) and downstream (DS) cathode busbars as shown in Figure 1. It is connected to the cathode busbar on one end and to the cathode collector bar on other end either by bolting or by welding. The DC current collected by the cathode busbar is then fed into the anode busbar of the adjacent downstream reduction cell through anode risers from one cell to another in the same way.

The main aim of this publication is to present the historical background and performance overview of conventional, as well as, new generation cathode flexible connections used across EGA cell technologies. The other aim is to highlight the way flexible connections are mounted on the cathode collector bars, as well as, on the cathode busbars. Mechanical flexibility is required in these connection members, for practical reasons, as it facilitates their handling and mounting, and avoids mechanical tension due to thermal expansion. Furthermore, the connection of the cathode collector bar to the cathode busbar should be of excellent electrical quality and reliability. In particular, it should not lead to a significant voltage drop, should not be subjected to excessive corrosion, and more generally it should not degrade over time.

2. Conventional Cathode Flexibles Used in EGA Cells

In the sections 2.1 to 2.3 below, the overview of the conventional bolted cathode flexible connections used across EGA cell technologies is described. The following aspects are discussed in detail;

- Historical overview and design concept
- Performance evaluation
- Pot cut-out statistics linked to the failures in flexible connections

2.1. Historical Overview and Design Concept

The conventional cathode flexibles with copper tabs have been installed in various cell technologies ever since EGA began its operations in 1979. In these flexible connections, a number of thin aluminium sheets are grouped together and then welded to the copper tabs. The copper tabs are then bolted to the steel collector bar on one side. The other end of the aluminium flexibles are permanently welded to the cathode busbar. Each end of the collector bar has two sets of flexible connections wherein one copper tab is bolted on the top face of the collector bar and the other tab is bolted on the bottom face of the collector bar. The collector bar faces, which are bolted to the copper tabs, are machined with high quality surface finish to achieve excellent surface contact between the two contacting surfaces.

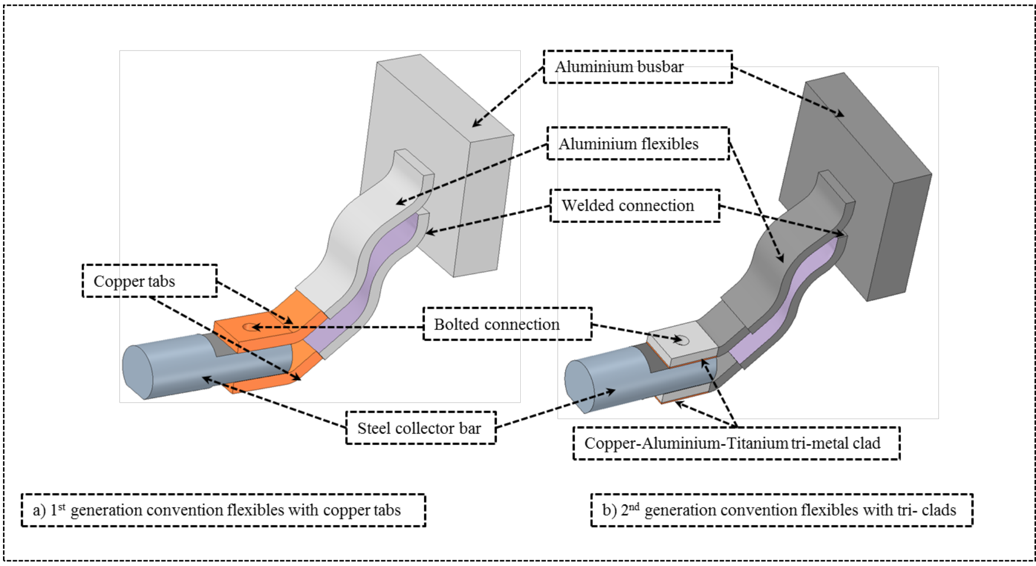

Figure 1. Conventional cathode flexibles: a) with copper tabs b) with tri clads.

Figure 1 shows a 3D Inventor geometrical model of the first generation cathode flexibles with copper tabs and more recently modified second generation conventional flexibles with tri-metallic clads. During pot turnaround, the copper tabs are unbolted from the collector bar ends. The flexibles, along with the copper tabs, are left in the potroom as they are permanently welded onto the cathode busbars. The quality of the bolted contacts is controlled with the periodic measurements of the combined voltage drop. The combined voltage drop at EGA is measured

4. Conclusions

EGA has successfully designed, modelled, tested and patented [3] the concept of new generation cathode flexible connections. After the successful test carried out in seven trial cells of D18+ cell technology, more than 500 D18 cells have been converted to D18+ cells [4 - 6], and have been installed with the new flexible connections at an industrial scale at EGA's Jebel Ali smelter. The new generation flexibles have also been successfully tested in five test cells of low energy DX+ Ultra cell technology and would be implemented at an industrial scale in ALBA's Potline 6, with 424 cells of DX+ Ultra cell technology. The new flexible connections have also been installed in seven trial cells of D20+ and four trial cells of DX Cell Technology.

Experimental evaluation of new cathode flexible connections shows an excellent agreement with the model prediction for D18+, D20+, DX and DX+ Ultra designs. These flexible connections have been standardized to be used for any future cell technology or expansion projects to be executed by the EGA. In the long run EGA will get the benefit of lower cost by implementing the new flexible connections both due to the saving in flexible voltage drop between 10 - 15 mV as well much lower flexibles cost. The pot turnaround and replacement cost is also favorable and these flexibles are expected to give better long term performance and quality of the bolted joints. Any deviation from acceptable contact voltage drop on aluminium-to-aluminium bolted joints can be controlled by periodic voltage drop measurements and subsequent joint re-tightening.

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6. References

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