EGA Experience with Full Copper Cathode Collector Bars

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Abstract

Cathode voltage drop (CVD) is an important component of pot voltage. Many initiatives to lower CVD have been implemented in the industry. One of them is copper inserts in the collector bars which has been implemented successfully in many smelters. Recently, this idea has been pushed further by using full copper collector bars that are sealed in the cathode blocks in new, innovative ways without the need for cast iron rodding. The approach aims to achieve two key objectives: reducing CVD and improving current distribution in the pot. A previous paper described the design, preheat, start-up and performance of the proprietary and patented full copper collector bar design test pot (Cu pot) in Emirates Global Aluminium (EGA) [3]. Building on the initial encouraging results of the first pot, several other full copper collector bar pots have been put in operation in different EGA pot technologies. This paper describes the performance of these pots, comparing full copper collector bars pot to collector bar copper insert pots in terms of cathode voltage drop, specific energy consumption, and current efficiency. Results of autopsies of Cu pots are also presented, showing that due to direct contact between carbon and collector bars, an aluminium-copper alloy with high electrical resistivity formed in a surface layer of copper, which is getting thicker with pot age. This layer is ultimately responsible for faster CVD increase with pot age than expected.

Keywords: Full copper collector bars pot, Copper insert pots, Industrial trials.

1. Introduction

One of the recent EGA initiatives for lower specific energy consumption (SEC) in pots was the implementation of full copper collector bars in cathode blocks according to a proprietary, patented design [1-2]. The fist test Cu pot was started up on 10 May 2018 in D20 technology and was successfully operated until the age of 1002 days when it was stopped for cathode surface inspection and then restarted [3]. The average CVD gain was 121 mV with respect to a group of control pots with steel collector bars and 60 mV with respect to a group of collector bar copper insert pots at 275 kA, during the first 1002 days [3]. After the restart, the CVD was higher than before, but the pot continued operating until its planned cut-out at the age of 1405 days.

The initial results of the first Cu pot were encouraging, and EGA expanded the trials to other Cu pots, so that in October 2021 there were already 12 trial Cu pots in operation [3]. The expansion continued so that now EGA has experienced running 30 different pots with full copper collector bars across various technologies at both sites, Jebel Ali and Al Taweelah, with 60 % of these pots still alive. The majority of these pots are from the CD20 and D20 technologies, with only five pots each in DX and DX+ Ultra technologies. In full copper pots, average cathode resistance was by approximately 0.1 μΩ lower than in copper insert pots, regardless of the technology, except in D20, where the gain was approximately 0.16 μΩ. Figure 1 shows the distribution of trial Cu pots among different EGA technologies.

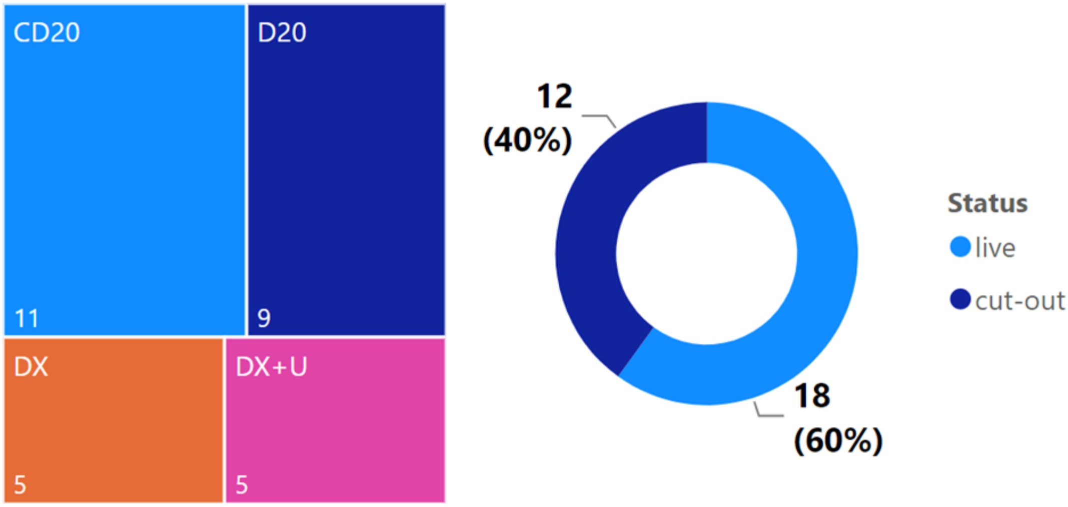

Figure 1. Trial Cu pots across EGA technologies as of June 2024.

Autopsies of several Cu pots were made, and varying degrees of damage on Cu collector bars was found. Most notably, the surface layer of the collector bars was converted to a copper-aluminium alloy of significantly higher electrical resistance and lower melting point than pure copper. This is consistent with the findings of other trials with full copper collector bars in direct contact with carbon [4].

2. Trial Pots

Table 1 gives all pots have or had ever operated with full copper bar design on EGA sites. Pot L5C251 (the fist row in Table 1) is the restart Pot L5C269 (the second row in Table 1); this is the first trial pot, described above. Of all Cu pots, only the first one was given special follow-up with many measurements reported in [3]. All other Cu pots were operating as the rest of the potline. Particular attention should be given to maximum bath temperature because of the low melting point of copper of 1084 °C.

The restart operation involving full copper pots was conducted on only two occasions. the first pot with full copper design, as previously mentioned, was one of them. It was intentionally restarted after 1,100 days to evaluate the condition of the cathode surface and to gain experience in restarting a fully copper pot, along with addressing the associated new challenges [3]. In contrast, the second restart attempt was entirely unplanned. It involved a CD20 technology pot with a full copper design, specifically Pot L5C159, which had to be cut-out after just 64 days of operation due to a special reason. The pot was subsequently restarted in Pot L5C092, which is still in operation and has now reached 1 174 days of service.

To assess the performance of each full copper pot, we selected a group of equivalent control pots from the copper insert collector bar design, ensuring that the control pots had the startup date within 1-2 months of the corresponding full copper pots and preferably from the same potline. We organised the copper pots into groups or batches based on their technology and start-up period. Using this classification, we matched each group of full copper pots with a corresponding group of control pots. There were 9 control pots D20, 18 in CD20, 10 in DX and 5 in DX+ Ultra.

melts the bar, ultimately increasing cathode resistance. Since the copper is already operating close to its melting point, only a small amount of additional energy is needed to trigger localised melting. Once this cycle begins, it is difficult to break and it operates similarly to a snowball effect.

Another challenge with the performance of most Cu pots is their relatively high energy consumption and instability. The primary issue appears to be excessive heat loss through the copper bars, escaping outside the pot shell. This excessive heat flow prevents operators from making the necessary adjustments to optimise and reduce energy consumption.

7. References

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