

Amperage Increase in DX+ Ultra Demonstration Cells at EGA's Jebel Ali Smelter

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Abstract



DX+ Ultra is EGA's low specific energy consumption, low CAPEX cell technology that was started up in March 2014 using five demonstration cells at 450 kA in Potline 5 Eagle Section in Jebel Ali smelter. After successful demonstration of the technology performance at amperages up to 460 kA, ALBA chose the DX+ Ultra technology for its Potline 6 smelter expansion in 2016. EGA then decided to stop the five demonstration cells and build three cells with the modified cathode design to be used at Alba, but also restart the two remaining cells. The three Alba design cells and the other two cells restarted at 460 kA in the period May to June 2017. After one year of successful operation the amperage was increased to 470 kA to increase cell productivity. This was achieved on 30 July 2018 where it stayed for 8 months. The next stage of development was to raise the amperage further to 480 kA. This was achieved on 22 April 2019. Operating the cells at 480 kA for almost 2 years resulted in an outstanding performance before the cells were finally stopped on 26 March 2021. A new, even higher productivity and lower specific energy consumption DX+ Ultra technology is in the making during the writing of this paper. Continuous development of cell control and monitoring as well as establishing the amperage increase strategy are valuable assets for the support of DX+ Ultra technology clients. In this paper, cell performance, challenges and solutions at various stages of amperage increase will be presented.

Keywords: DX+ Ultra Technology, Amperage increase, Cell performance.

1. Introduction

EGA is the largest industrial company in the UAE outside oil and gas and the world's biggest 'premium aluminium' producer. EGA operates aluminium smelters at Jebel Ali in Dubai and at Al Taweelah in Abu Dhabi, with a combined production capacity of 2.51 million tonnes of cast metal in 2020. The smelter in Jebel Ali has seven potlines operating six home-grown cell technologies: D18+, CD20, D20, D20+, DX and DX+ Ultra. The smelter in Al Taweelah has three potlines operating three technologies: DX in potlines 1 and 2, DX+ in Potline 3 and DX+ Ultra in the most recent extension of Potline 3 [1].

In the Jebel Ali smelter Potline 5 holds a test section named the Eagle Section where EGA can demonstrate new technology in a group of five cells. For example, the original DX technology was demonstrated in this section from 2005 to 2010 and then implemented in Potlines 1 and 2 in Al Taweelah between 2010 and 2011. The DX+ technology was tested from 2010 to 2014 followed by implementation in Al Taweelah Potline 3. The latest development was DX+ Ultra technology that was tested from 2014 to 2021. After successful demonstration of DX+ Ultra technology from 2014 to 2016, Aluminium Bahrain (Alba) selected the DX+ Ultra technology

for its Potline 6 expansion project that commenced 2016. The five DX+ Ultra demonstration cells were stopped on 18 March 2017 and had achieved cell ages from 1050 to 1102 days. Two cells (no. 273 and 274) were rebuilt as industrial (Alba) design with asymmetric busbars and some modifications to the cathode lining. One cell (no. 277) had only the Alba cathode design and no changes made to the busbar. The two remaining cells (no. 275 and 276) were restarted without any changes. These cells started up from 18 May to 18 June 2017 at 460 kA [2]. The restarted cell no. 276 was cut out on 18 July 2019, rebuilt and bathed-up again with Alba cathode design on 24 August 2019. The restarted cell no. 275 was cut out on 4 January 2020 at the age of 2007 days, rebuilt and bathed-up with Alba cathode design on 26 January 2020. All cells were ultimately stopped on 26 March 2021 while operating at 480 kA. They are presently being rebuilt with a more advanced cathode design with the intention to operate them at 500 kA.

In this paper the performance of DX+ Ultra Eagle cells will be reviewed and analysed at amperages of 460 kA, 470 kA and 480 kA.

2. Amperage Increase Strategy

The DX+ Ultra cells started up at 450 kA between March and May of 2014. An amperage of 455 kA was reached shortly after that on 18 July 2014. Thereafter, various amperages up to 469 kA were tested, but then the amperage was taken down again to 455 kA during the period starting 14 February 2015 until 6 September 2016. Following that, the amperage started to be increased again and reached 460 kA on 19 September 2016. It stayed at 460 kA until 3 July 2018. An amperage of 470 kA was reached on 30 July 2018 where it was kept until 4 April 2019. After a period of increases, an amperage of 480 kA was reached on 22 April 2019. It was held at this level until 26 March 2021 when all pots were cut out. Figure 1 shows the amperage evolution and the associated cell voltages.

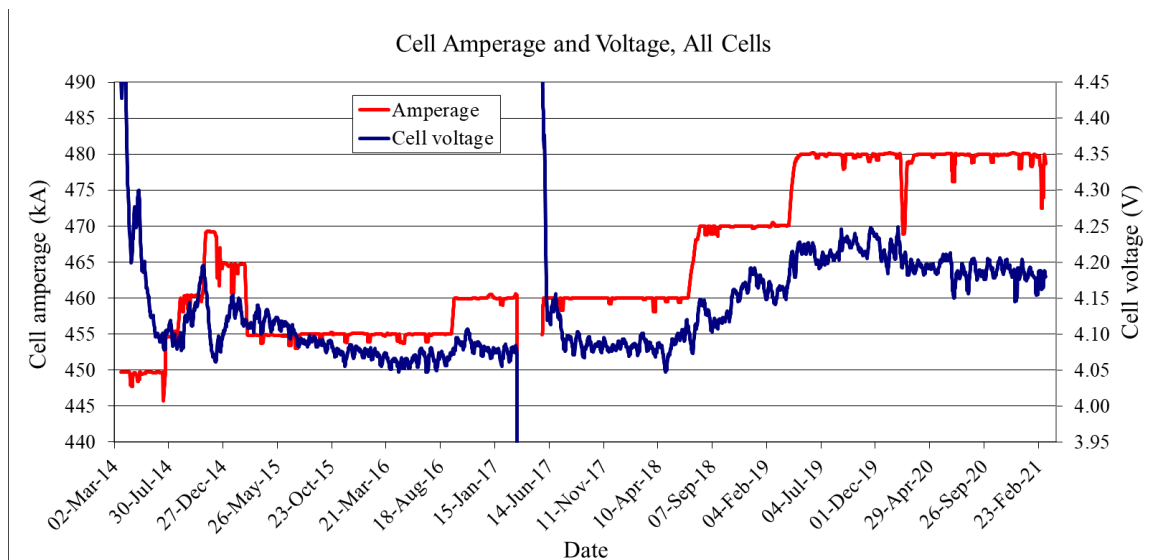


Figure 1. Cell amperage and average voltage of all five DX+ Ultra cells from the original start-up in 2014 to 26 March 2021. High voltages are at the original start-up and at the start-up of the industrial cells.

The cell performance at 455 kA has previously been reported by Alzarooni et. al. for the period of 1 June 2015 to 31 August 2016 (15 months) [3]. The performance was excellent with 95 % current efficiency, specific energy consumption of 12.8 kWh/kg Al and net carbon consumption of 402 kg C/ kg Al. In the present paper, the performance at 460 kA, 470 kA and 480 kA will be

Table 2. Performance of DX+ Ultra demonstration cells.

Parameter	Unit	1 Sept 2017 - 29 Jul 2018	30 Jul 2018 - 21 Apr 2019	22 Apr 2019 - 25 March 2021	1 Sept 2017 - 23 March 2021
Target amperage	kA	460	470	480	N/A
Actual amperage	kA	460.39	470.27	479.43	472.52
Current efficiency- tapped	%	93.65	93.31	93.47	93.48
Current efficiency - corrected for metal height change	%	93.65	93.69	93.54	93.60
Metal production (calculated with corrected CE)	kg/cell-day	3472	3548	3611	3561
Net cell voltage	V	4.09	4.15	4.20	4.16
BRSP	$\mu\Omega$	5.15	5.20	5.19	5.18
Net specific energy (DC)	kWh/kg Al	13.0	13.3	13.4	13.27
Net carbon consumption	kg C/t Al	405	407	413	410
Gross carbon consumption	kg C/t Al	530	528	547	539
Excess AlF ₃	%	9.4	9.4	9.9	9.6
Bath temperature	°C	966	965	962	964
Metal height before tap	cm	20.2	22.7	24.5	23.0
Fe	%	0.036	0.040	0.042	0.041
Si	%	0.023	0.024	0.038	0.034
Anode effect frequency	AE/pot-day	0.046	0.031	0.052	0.046
Anode effect duration	s	13.2	11.2	12.1	12.8
PFC emissions, CO ₂ equiv.*	CO ₂ kg/t Al	10.9	6.2	11.5	10.7
Cathode voltage drop	mV	194	203	212	206

*CO₂ equivalent is calculated as in Reference [11], using the Tier 2 method and SAR (Second Assessment Report).

6. Conclusions

EGA has successfully increased amperages in DX+ Ultra demonstration cells from 450 kA to 480 kA. During amperage increases from 460 kA to 480 kA the metal production in industrial cells increased by 139 kg/cell-day. Current efficiency and specific energy consumption remained practically constant during the amperage increase. Metal purity was excellent and, CO₂ equivalent of PFC emissions was world benchmark.

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