# Behavior of Different Lining Designs with Forced Convection Network in High Productivity Pots in Alba

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**Abstract**

At Aluminium Bahrain (Alba), one of the world's largest single-site aluminium smelter outside of China, in reduction Lines 4 & 5, line amperage successfully increased from 400 kA to 412 kA in a short record period after Forced Convection Network (FCN) installation. During the amperage increase journey, two different lining designs were used. Alba is planning to increase amperage further to 415-420 kA during the next 2 - 3 years. In line with this amperage increase plan, two more lining designs were added. Both lines are currently operating at 412 kA, and three of these lining designs are in operation. The behavior and challenges of different lining designs with amperage increases after FCN installation along with the future preparation are discussed in this paper.

**Keywords:** Aluminum smelter, Forced Convection Network (FCN), Amperage increase, Different lining designs.

## 1. Introduction

Alba embarked on a journey towards high productivity and high amperage technology with Line 4 in 1992, featuring 288 reduction cells using AP30 technology. This was followed by Line 5 - the longest potline at that time (2005), with 336 reduction cells using AP30 technology [3]. In the year 2021, Alba achieved a significant milestone by increasing the current in both potlines to 400 kA without implementing FCN [1]. At present, Alba has introduced three different lining designs with copper insert—Alba copper design, AP40A design, and CP20 design across lines 4 and 5. Alba Copper design was the 1st design when Alba has introduced copper insert collector bar, AP40A design was also a copper insert collector bar design given by Aluminium Pechiney and CP20 design is an increased copper cross section design developed along with CAETE. Each design, implemented at different intervals, has the objective to optimize thermal and electrical balance in line with the prevailing current increase strategy. The integration of cutting-edge technology enabled Alba to increase potline current while maintaining commendable current efficiency, setting a global benchmark among AP30 potlines.

As Alba strived to surpass the 400 kA threshold, FCN implementation became necessary for its two AP30 potlines, i.e., Lines 4 and 5, comprising a total of 624 reduction cells. FCN exhibited

varying behaviors across different lining designs, prompting Alba to devise tailored strategies and to adapt accordingly.

## 2. Technical Background

Maintaining optimal operational conditions and current efficiency while managing current increase presents a notable challenge in sustaining the thermal balance of reduction cells. This balance is crucial for maximizing both technical and economic benefits. Alba has effectively tackled the thermal balance of its reduction cells through various ways of small and big improvements.

### 2.1 Journey of Line 4-5 Current Increase

Line 4 commenced operations with the AP30 design in 1992 at 295 kA, whereas Line 5 commenced operations with the AP30 design in 2005 at 330 kA. Between 1992 and 2005, Line 4 underwent amperage increase from 295 kA to 333 kA. The strategies and modifications implemented to accommodate the demands of current increase in Line 4 are detailed in Table 1.

**Table 1. Strategies and modifications implemented in line 4 during 1992-2005 [3].**

| Strategies and Modifications | Benefits |
|---|---|
| Second generation cells started with graphitized cathode. | • Cell voltage reduced by 30 mV due to lower cathode resistance. |
| Anode length increased from 1450 mm to 1500 mm | • Saving of 100 mV. |
| Double anode slot of 150 mm was introduced. | • Saving of 50 mV. |

Since the establishment of Line 5, the lining design of Line 4 has also been modified to align with Line 5 design, indicating that both lines have operated with the same lining design since 2005. From 2005 to 2014, in Lines 4 & 5, the amperage increased from 333 kA to 360 kA in Line 4 and to 370 kA in Line 5. The strategies and modifications implemented to address the demands of current increase in both Lines 4 & 5 are outlined in Table 2.

**Table 2. Strategies and modifications implemented in line 4 during 2005-2014 [3].**

| Strategies and Modifications | Benefit |
|---|---|
| Lines 4 & 5 started with graphitized cathode block of 450 mm height, which changed to 490mm height.<br>Steel collector bar cross-section changed from 150 mm x 100 mm steel bar to 122 mm x 122 mm squared steel bar. | • Higher cathodes and lower height of collector bar (without compromising cross section) contribute to reduce current density gradients, and thus improving stability level of cells at higher currents. |
| SiC side wall was replaced by composite side wall of SiC and prebaked carbon side wall. | • The carbon insert used in the sidewall improves the heat flux from the inside to the outside. This effect is essential to have a secure ledge profile at the sidewall. |
| Anode slot increased from 150 mm to 270 mm. | • Saving of 50 mV. |
| Anode length increased from 1520 mm to 1600 mm. | • The heat loss from the top increased. |

To address the requirements of current increase, Alba initiated significant alterations in the lining design of Lines 4 & 5 since 2014. Various design types, along with their initiation, stoppage, and continuation periods, are illustrated in Figure 1.

These major modifications and improvements in cell design and auxiliary units were conducted to facilitate amperage increase, all based on in-house technical studies and the implementation of state-of-the-art innovations.

## 5. Conclusion

Alba has successfully increased line current by 12 kA with implementation of FCN. While doing so, different lining designs were operating successfully in both lines 4 and 5. Technical expertise, operational proficiency, and organized teamwork helped Alba team finding the optimal settings and operational practices to operate and advance different lining designs with different specifications. The journey of current increase is anticipated to continue in the soon upcoming years and the target is set to reach 420 kA and beyond in Alba potlines 4 and 5.

## 6. References

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