Relocation of a 400 kA Potline – Pot Upgrade and Energy Saving Roadmap

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Abstract

In 2018, a Chinese 400 kA potline was shut down due to high energy consumption and lack of competitiveness. The potline was originally designed in 2006 as the first-generation 400 kA reduction cells by a Chinese aluminum reduction technology provider. In order to survive in the fierce competition, the smelter decided to relocate from Henan Province to Sichuan Province, a place that has abundant hydroelectric power resources and a larger environmental capacity. Guiyang Aluminum & Magnesium Design and Research Institute Co., Ltd. (GAMI) was selected as technology provider for this relocation project. In order to achieve lower power consumption targets, pot upgrading and modifications to the auxiliary systems were decided for this project. After upgrading, the potline was successfully restarted in November 2019, and its specific energy consumption was 500 kWh/t Al lower than before. This article shares the energy saving roadmap of this relocation project.

Keywords: Aluminum reduction potline relocation, Pot technology upgrading, Energy saving.

1. General Description

This project constitutes a relocation initiative involving the transfer of operations from Henan to Sichuan. Its original configuration contains a single potline, equipped with a total of 234 cells. The potline was originally designed in 2006 as the first-generation 400 kA reduction cells by a Chinese aluminum reduction technology provider. To mitigate financial outlay, the underlying design philosophy prioritizes the relocation of existing large-scale equipment from each workshop, obviating the need for new purchases. Consequently, the core equipment remains unaltered, while selective optimization and transformation are implemented on specific components, thus fostering advantageous circumstances conducive to achieving improved technical and economic performance indicators. Figure 1 shows the relocation project timeline.

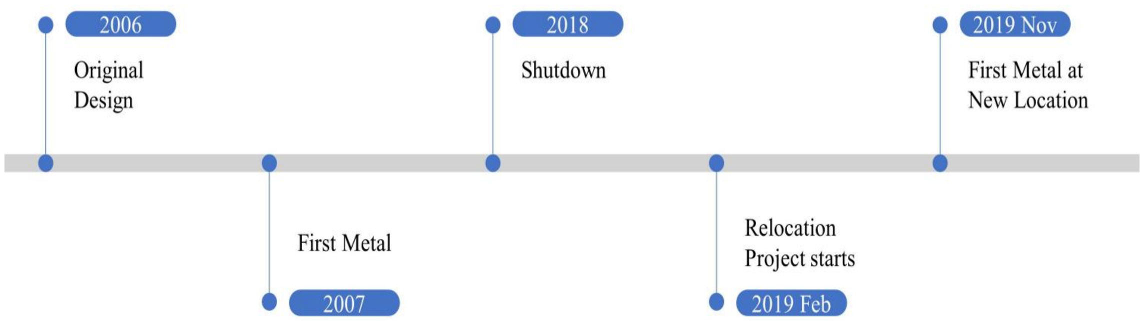

Figure 1 Relocation project timeline.

2. Busbar System

As known, the main driving force for the molten metal and bath inside the cell is the electromagnetic force:

$$\mathbf{F} = \mathbf{J} \times \mathbf{B} \tag{1}$$

where:

F Electromagnetic force vector, N/m^3,
J Electric current density vector, A/m^2,
B Magnetic induction (flux density), T (or G), 1 mT = 10 G,
X Vector cross product

Therefore, the horizontal current in the metal layer and vertical magnetic field create the wave-driving force, which is mainly generated by the magnetic field of the busbar system. Due to the limited investment of the owner in this project, the owner's requirement for the busbar system of this project was to maximize the utilization of the old busbars. Therefore, GAMI's approach was to first calculate the magnetic field of the existing busbar system.

Calculation results of original design show that the magnetic field is high. Maximum vertical magnetic field |Bz| is 2.78 mT (27.8 G), while the average value of |Bz| is 0.62 mT (6.2 G). The area with |Bz| < 1 mT (10 G) accounts for 83.3 %. Values and distribution of vertical magnetic field are indicated in Table 1 and Figure 2.

Table 1. Magnetic field distribution in four quadrants before busbar modification (G).

	1st quadrant	2nd quadrant	3rd quadrant	4th quadrant
$\lvert B_z \rvert$	6.15	6.36	6.41	5.89

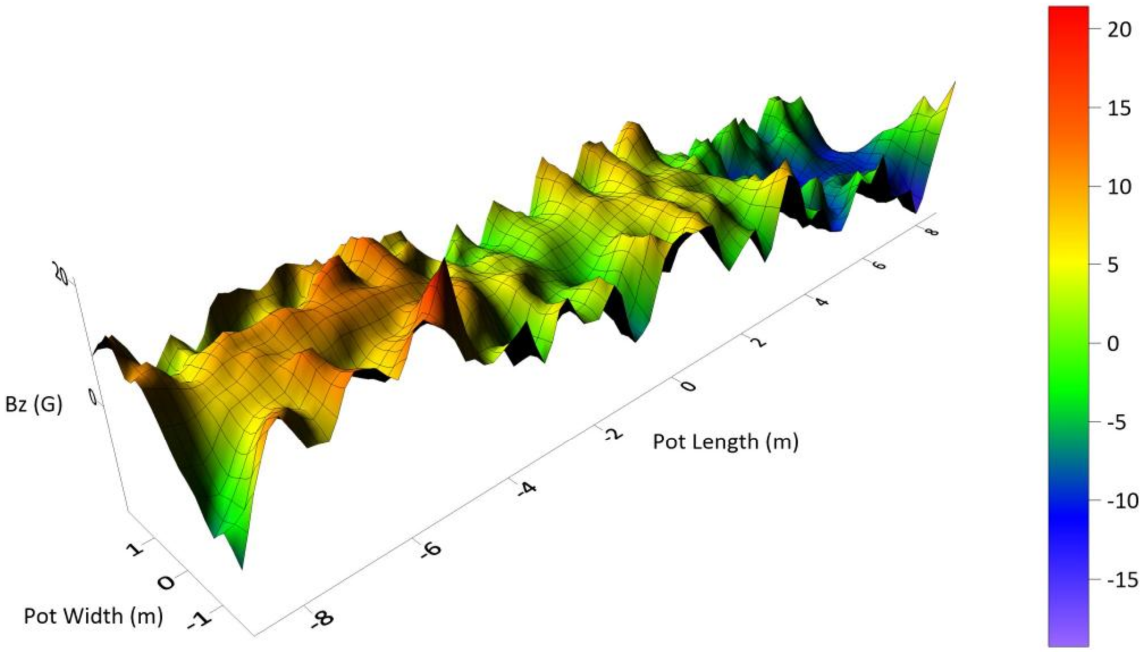

Figure 2 B$_z$ Distribution before busbar modification (G).

Starting from the research by Sele [1], magnetic field judgement criteria was described. However, those criteria cannot meet the requirements for today's MHD stability. According to the evaluation criteria established by GAMI during the development of large-scale cells, in order to obtain good MHD stability, the vertical magnetic field must meet the following criteria [2]:

Figure 10. Retrofitted potroom (photo taken in May 2023).

9. Conclusion

This project successfully relocated an old 400 kA aluminum electrolysis potline, and after a series of upgrades, it reduced its operating power consumption by more than 500 kWh/t Al. In addition to upgrading and transforming the traditional cell to save energy, this project also saves a lot of power consumption in the auxiliary system, which shows that the new concept of public and auxiliary system design can bring huge economic benefits to the aluminum plant. The possibility of reducing the power consumption by modifying the auxiliary system is usually ignored by smelters, and this project sets a very good example for the future of old smelters.

10. References

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