Application of SAMI Intensive-Current and Energy-Saving Technology in a 240 kA Potline

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Abstract

Due to the proposal and implementation of national dual-carbon strategic goal in China, Shenyang Aluminum and Magnesium Engineering and Research Institute Co., Ltd (SAMI) has carried out a series of technical research and improvement projects at home and abroad since 2015. In 2022, Guangtou Yinhai Aluminum Co., Ltd implemented an upgrading project on their 240 kA potline. This project involved adopting various technical strategies from SAMI such as enhancing magnetohydrodynamic (MHD) stability, utilizing New Conceptual Cathode Technology (NCCT), implementing the "Long Healthy Life" potlining design, and incorporating energy-saving superstructures. The current of this potline was increased to 260 kA, and energy consumption of the potline was reduced to 12.472 kWh/kg Al from 13.350 kWh/kg Al. Statistical data demonstrated that the production capacity increased by approximately 14 000 tonnes per year for the potline. Current efficiency was increased by 4.32 %, achieving the expected goals for the technical upgrade with significant energy saving and production increase. These technologies offer robust support to the aluminum industry in upgrading its current low-amperage reduction cells, leading to lower carbon dioxide emissions.

Keywords: NCCT Technology, "Long Healthy Life" potlining design, MHD stability, Production increase, Carbon emissions.

1. Introduction

China's strategic goal of carbon peaking and carbon neutrality has put forward the requirements of "dual control of both energy and consumption" for the aluminum smelting industry [1]. Especially after the implementation of the "Tiered electricity pricing" policy, energy consumption of aluminum smelters will be directly linked to the price of electricity. High energy consumption and high electricity price will inevitably affect the survival of some aluminum smelters. The entire Chinese electrolytic aluminum industry urgently needs to accelerate technology upgrading for energy saving and carbon reduction.

SAMI is the forerunner and leader in the development of aluminum electrolysis technology in China. Since 2015, SAMI has developed a complete set of deep energy-saving and green low-carbon aluminum electrolysis technology systems, focusing on goals of improving MHD stability of aluminum reduction cell, maintaining good thermal balance and systematically reducing energy consumption, by means of theoretical research based on multi-physical field simulation of aluminum reduction cell, combined with industrial tests, smelter applications and field test verification. The technical route of this technology system is as follows:

- Starting from the essence of aluminum electrolysis process, to optimize the electro-magnetic field and conductive structure design with the aim of improving MHD stability and reducing voltage drop of the cell, establish the foundation for stable cell operation under low anode and cathode distance (ACD), low voltage, and higher current density.
- Research the characteristics of temperature and stress distribution of the lining and potshell under low ACD, low voltage, and higher current density. Optimize the thermal balance design, upgrade the matching lining design and anti-deformation potshell structure, so that the cell can maintain a "Long Healthy Life" under the condition of low energy consumption.
- Develop an energy-efficient and eco-friendly cell superstructure by optimizing the gas flow field. These enhancements aim to achieve an energy-saving and highly efficient fume collection system.
- Develop cell control system with intelligent crust-breaking and alumina feeding system for uniform distribution of alumina concentration, taking into account bath flow.
- Explore production process management technology of aluminum reduction cell under low ACD, low voltage, and higher current density. Integrate production operation control with design concepts to promote a refined, standardized, and intelligent production process management system.

Following the outlined technical path, SAMI has successfully developed numerous sub-technologies. Including:

- MHD stability enhancement technology such as Networked Self-equalizing Busbar Technology (NSBT) and New Conceptual Cathode Technology (NCCT) [2-4],
- "Long Healthy Life" lining technology,
- Energy-saving and eco-friendly superstructure technology,
- Production process management technology of aluminum reduction cell under low ACD, low voltage, and higher current density, etc.

Furthermore, in 2022, the aforementioned energy-saving technology system for aluminum electrolysis was successfully integrated and implemented in the 240 kA potline upgrading project of Guangtou Yinhai Aluminum Co., Ltd. Following the optimization and upgrade provided by this technology system, the operational current of the 240 kA potline has been successfully increased to 260 kA. After being reactivated, the upgraded cells have been operating stably and achieving favorable process technical indicators. They demonstrate clear advantages in terms of energy efficiency and increased productivity.

2. Potline Operation Conditions Before Upgrade

Prior to the upgrade, this 240 kA potline had been in operation for more than 15 years, with the following significant issues:

- The cell suffered from poor MHD stability, failing to meet the requirements for stable production and operation at low ACD. The anode current density was as low as 0.733 A/cm^2, energy utilization rate and unit labor productivity were also low.
- 30 % graphitic cathode carbon block was used, the average cathode voltage drop (CVD) and external busbar voltage of the cell was more than 310 mV and 250 mV respectively. Most cells ran with poor ledge profiles, relatively cold corners, and high potshell bottom temperature.
- The superstructure of the cell utilized a low-type fume collection structure. However, this design led to excessive ash accumulation in the duct, increasing gas collection resistance and decreasing gas collection efficiency. Consequently, the fume collection and scrubbing system exhibited high energy consumption. Most of the time, the traditional pneumatic-controlled crust-breaking and feeding system had a great impact

The successful implementation of this technical upgrade project has set a record for the most significant energy-saving and consumption reduction in the technology upgrading of China's aluminium smelters. This achievement holds significant reference value for the technology upgrade, energy-saving, and efficiency improvement of other aging aluminium smelters.

6. References

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