Development and Application of Key Technologies for Energy-saving, Low-carbon, and Digital-intelligent Aluminium Electrolysis

Jie Li
Professor
Central South University, Changsha, Hunan, China
Corresponding author: lijieyejin@csu.edu.cn
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Abstract

This study has established key intelligent optimization technologies for aluminium reduction, based on distributed sensing and digital twin systems. The number of online detection parameters for a single electrolytic cell has been expanded from the traditional 2 types (2 data points) to 7 types comprising a total of 297 data points, improving the accuracy of alumina concentration control within the cell by 80 %. Carbon dust free prebaked anode production and application technology has been developed, increasing the number of control indicators from 8 to 20. This reduced carbon dust generation per tonne of aluminium by 50 %, enabling stable carbon dust-free operation (no manual carbon dust skimming for removal) in aluminium electrolysis. An energy-saving technology for aluminium electrolysis featuring stabilized flow and insulation was also created, improving magnetohydrodynamic (MHD) stability by 40–60 % and reducing cathode voltage drop by 50 %. Since its large-scale application in China in 2016, the technology has led to significant results: current efficiency increased by 0.5–1.45 %, DC power consumption reduced by 200–623 kWh per tonne of aluminium, and labor productivity increased by 30 %.

Keywords: Intelligent technologies, Distributed sensing, Digital twin systems, Energy-saving technology.