Application of RuC Technology in 600 kA Aluminium Reduction Cells

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Abstract

The ready to use cathode (RuC) technology has transformed the cathode assembly method, and by optimizing the cathode structure and upgrading the collector bar material, the average horizontal current in the aluminium pad has decreased by nearly 70 % compared with conventional cathode structure with steel collector bars, which significantly improved the magnetohydrodynamic (MHD) stability of the aluminium reduction cell. The cathode voltage drop (CVD) of the 600 kA RuC cell is about 150 mV, which is 50–100 mV lower than in conventional cathode cell, and the CVD of RuC cells is relatively stable for a long time. High MHD stability and low CVD create favourable conditions for stable and efficient operation of the reduction cell at low voltage.

By the end of December 2024, RuC technology has been applied in more than 110 aluminium reduction cells in Weiqiao 600 kA potlines, with of the oldest cells of 4.5 years. The cells operate smoothly and efficiently with excellent key performance indicators (KPIs). The cell voltage is 3.86–3.90 V, the current efficiency exceeds 94 %, and the DC energy consumption is about 12 300 kWh/t Al. Based on cathode wear measurements, the expected cell life will be significantly longer than in conventional cells. The application of RuC technology will be further expanded in Weiqiao smelters.

Keywords: Ready to use cathode (RuC), 600 kA aluminium reduction cell, Low energy consumption, High current efficiency, Long cell life.

1. Introduction

China is actively adopting stronger policies and measures towards carbon neutrality. In accordance with dual carbon goal, to reach carbon peak before 2030 and carbon neutrality by 2060, announced by President Xi Jinping on UN General Assembly on 22 September 2020, several pledges towards this goal have been announced, such as:

"By 2030, China's carbon dioxide emissions per unit of GDP will drop by more than 65 % compared with 2005, the proportion of non-fossil energy in primary energy consumption will reach about 25 %, the forest stock will increase by 6 billion cubic meters compared with 2005, and the total installed capacity of wind and solar power will reach more than 1.2 billion kilowatts." [1].

Aluminium is the most widely produced non-ferrous metal in the world, with nearly 60 % of primary aluminium produced in China, according to International Aluminium Institute

statistics [2]. Aluminium reduction is a major consumer of electricity, consuming more than 580 TWh of electricity, accounting for approximately 7.5 % of China's total electricity consumption. Electrolytic aluminium carbon dioxide emissions account for about 75 % of the total emissions in the non-ferrous metal industry and about 3.5 % of the total carbon dioxide emissions in China.

In 2024, China's primary aluminium production reached 43.396 million tonnes [2]. The peak production capacity of primary aluminium has become one of the key industries for carbon emissions peaking. According to [3]:

"In recent years, the national supply side reform has achieved {good} results, with limited increase in production capacity on the supply side, increased demand for clean energy aluminium on the demand side, and tight supply and demand leading to an aluminium per tonne high profit market."

With the deepening implementation of the national "dual carbon" strategy and related industrial policy requirements, the electrolytic aluminium industry is facing a challenge of reducing carbon dioxide emissions. Accelerating the key technology research and major demonstration project construction for energy-saving and carbon reduction in electrolytic aluminium is the important task for the survival and development of smelters. Based on the requirements of government policies, starting from 2025, the comprehensive AC power consumption of liquid aluminium has to be lower than 13 300 kWh/t Al (excluding desulfurization power consumption). Chinese aluminium reduction companies are actively searching for technologies and ideas to further reduce aluminium reduction energy consumption.

2. Research and Development of Energy-Saving and Low-carbon Technologies in China

"Since entering the new century, China has made significant progress in the core technology of primary aluminium, with internationally leading technology for high amperage cells. 600 kA aluminium cell technology has been widely applied, and the average energy consumption per unit product has shown a significant downward trend overall." [3]

In 2024, the industry's average comprehensive AC power consumption was about 13 400 kWh/t Al, a decrease of 600 kWh/t Al compared to 2013.

In recent years, under the requirements of the national "dual carbon" emissions policy, the research and technology development in China's aluminium reduction industry have developed energy-saving technologies for the cathode structure of aluminium reduction cells, such as graphitized cathode blocks, large cross-section high conductivity collector bars, copper insert collector bars, etc., which have achieved varying degrees of energy-saving in different application scenarios [3].

3. RuC Technology Research and Application in China

In order to achieve further energy saving and carbon reduction, Shandong Weiqiao group, NEUI, Tokai COBEX and NFC collaborated to develop the "RuC energy-saving, long life, and high yield aluminium technology" with Tokai COBEX patented ready to use cathode (RuC) technology as the core [4, 5].

The RuC stability in cathode voltage drop (CVD) with low electrical contact resistance is achieved despite the lower contact surface area between the collector bar and carbon block (-60 %) compared to conventional cathodes. The low level and stable trend of CVD proves the robustness of the cathodic system [6].

5. References

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