The Practice and Effectiveness of Aluminum Reduction 4221-Process Technology in SPIC Nei Mongol Energy Co. Ltd

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Abstract

Since 2016, SPIC Nei Mongol Energy Co. Ltd., the inner Mongolia branch of China State Power Investment Group, has carried out process technology innovation for the existing 300 kA, 350 kA and 400 kA potlines, and gradually developed the aluminum reduction 4221-Process Technology, which consists of a new set of pot operation parameter targets and procedures. This technology has also been applied in all pots of the new 500 kA potline. Seven years of production practice has proved that the 4221-Process Technology improved the operation key performance indicators (KPIs) and significantly simplified pot operation. Compared with the domestic average value, current efficiency is by more than 2 % higher, pot life is by more than 400 days greater, the production of Al99.85 grade aluminum is by more than 30 % greater, and the AC power consumption is by more than 100 kWh/t-Al lower. Employee work intensity was reduced by more than 50 %. The 4221-Process Technology provides a remarkable progress towards more efficient and stable aluminum reduction operation, and greater economic and social benefits.

Keywords: Process management 4221-Process Technology; Reduce power consumption; Reduce labor intensity; Improve production efficiency.

1. Introduction

SY300, SY350 and SY400 technologies, a total of 918 pots, are built in SPIC Nei Mongol Energy Co. Ltd., the Inner Mongolia branch of China State Power Investment Group. The three potlines were put into operation from 2004 to 2011. Since August 2016, in order to solve the common problems of the industry, technical research has been carried out, and after five years of exploration, practice and optimization, the aluminum reduction 4221-Process Technology was formed. In addition to effectively improve the safety and stability of operation, the technology realizes high-current efficiency and low energy consumption, while greatly reducing the manpower and labor intensity. It also significantly improves the efficiency of equipment and the quality of operations. This technology has also been applied in all pots of the new 500 kA potline in 2022 and achieved good operational results.

This technology contains the following what technical features: Requirements for four parameters are low level, for one parameter are intermediate, and for two parameters are high. In addition, two process operations are discontinued. Low, intermediate and high requirements refer to the

control range of data within relatively low, intermediate, or relatively high values. Table 1 shows the requirements.

Table 1. Technical specifics.

Requirements	Quantity	Parameters
Low	4	Metal height, anode cover height, cryolite ratio (CR), bath temperature
Intermediate	1	ACD
High	2	Bath height, superheat
Discontinued	2	Scooping up carbon dust and Scooping up solid bath during anode change

2. Background Conditions

Since 2010, most aluminum smelters in China insisted to increase anode cover height and CR to achieve low voltage and moderate bath temperature [1]. However, reducing the voltage without improving the performance of the pot will inevitably result in too low anode-cathode distance (ACD) and pot voltage instability, so the metal height must be increased to improve stability. Thus, a contradiction arises. Although the power consumption has been reduced to a certain extent, the production operation is unstable. At the same time, the labor intensity and amount are large, and malignant production accidents are prone to occur.

The details are shown in Table 2.

1. The bath has high viscosity and poor fluidity, resulting in low solubility of alumina and difficult separation of carbon dust;
2. There is a lot of sludge and ridge (solidified sludge) on top of cathode carbon blocks and uneven distribution of cathode current, resulting in many early failures and short pot life. The ACD is too small and the anode current distribution is uneven, resulting in large voltage fluctuations and low current efficiency;
3. Production management is very difficult, and pot operators are tired;
4. Employees have high labor intensity and a lot of work, resulting in high manpower turnover rate;
5. The safety risk is too high, and vicious production accidents such as anode burn-offs, metal rolling, metal tap-outs, explosions at the pot bypass shunts, personal injury and potline shutdowns occur from time to time.

Table 2. Technical parameters of the previous process.

Process indicators	**Value**
Metal height, cm	25~30
Bath height, cm	17-19
CR (excess AlF_3, %)	＞2.45 (7.5)
Anode cover thickness, cm	25-35
ACD, cm	~4.1
Superheat, ℃	3-7
Cathode voltage drop (CVD), mV	＞320
Net pot voltage, V	＜4.000

3. Optimization Direction and Measures

The overall optimization process is based on the following ideas, which have been gradually implemented over the last 6 years.

5.4 Technology Adapted to High Current Efficiency and Low Energy Consumption

Production practice has proved that this process technology can not only adapt to the production mode of high current efficiency but is also suitable for the Chinese policy requirements of low energy consumption.

6. Conclusions

(1) The 4221-Process Technology of aluminum reduction has significant advantages in high-current-efficiency and low-energy-consumption production, and the technology is mature; it is a reference to be promoted in the industry.
(2) The 4221-Process Technology solves the problem of high labor intensity and large manpower requirement. To a large extent, the problem of high worker turnover rate has been solved. It can be used as a reference for other smelters.
(3) The process technology solves the problems of poor operational stability, short pot life and high production safety risk of earlier technology, and greatly reduces the potline shutdown risk caused by anode burn-offs, metal rolling, pot tap-out and explosion of the pot bypass shunts.
(4) The tiered electricity price policy requires the smelters to adopt graphitized cathodes. The high thermal conductivity of graphitized cathodes requires process technology with low metal height and higher superheat. Therefore, 422-Process Technology is also suitable for graphitized cathode carbon blocks.
(5) Aluminum reduction 4221-Process Technology provides a solution for efficient and stable operation of aluminum reduction smelters. The economic and social benefits are remarkable.

7. References

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