Reduction of Energy Consumption at Khakass Aluminum Smelter

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Abstract

Khakass Aluminum Smelter (KhAZ) is the first aluminum smelter launched by RUSAL in modern Russian history at the site of Sayanogorsk Aluminum Smelter. KhAZ consists of one line in two potrooms with 336 of Rusal's RA-300 cells. The first metal was produced in December 2006, and the design capacity was reached at the end of 2007: amperage 320 kA, current efficiency 94.6 %, specific energy consumption 13740 kWh/t Al. Later, taking into account market conditions, the amperage was decreased to 310 kA, and some energy saving measures were implemented, including:

- 100 % graphitic cathode blocks,
- Improved top anode shape; the anode width was increased by 1 cm,
- Increased anode cover height,
- Improved computer control,
- Decreased anode-cathode distance (ACD).
- The implementation of anodes that are 10 cm longer is in progress.

As a result, in 2020 the specific energy consumption was 12911 kWh/t Al, a decrease of about 800 kWh/t Al.

Keywords: Khakass Aluminum Smelter, RA-300 cells, Reduction of specific energy consumption, Increased anode length, Decreased anode-cathode distance.

1. Introduction

Khakass Aluminum Smelter (KhAZ) is the first successful experience of RUSAL in implementing a project on construction of a new smelter using its own resources. The first cell RA-300 was successfully developed, tested and implemented. The general designer of the smelter was the design institute RUSAL VAMI. The aluminum smelter was built within record-breaking time – 25 months – the first cubic meter of concrete was laid in the KhAZ foundation in October 2004, and the first metal was produced in December 2006. The design capacity was reached in November 2007.

KhAZ Reduction Area consists of two potrooms that have the same length (1224 m) and width (27 m) with the cells 3.0 m above ground level. The version of potrooms is two-storey, single row with pot center to pot center spacing of 6.5 m. The, potroom centers are connected by a passage that is 15 m wide, also in the southern and northern ends they are connected by transport passage that are 12 m wide. There are 336 RA-300 cells installed in total in two potrooms, 168 cells in each potroom. The cells are in a single-row, side by side arrangement. Each cell is equipped with four automated alumina point feeders and one automated aluminum fluoride point feeder, the anode body consists of 36 three-studded anodes each 1445 x 700 x 605 mm in size (in accordance with the initial project), the cathode shell is a single self-supporting unit, the side lining is silicon-carbide, the bottom is made of 48 carbon blocks with a graphite content of 30 %.

The potline is equipped with two Dry Gas Treatment Centers. Alumina is fed to bins of the automated alumina point feeder by a centralized alumina distribution system. Maintenance of cells is carried out by eleven pot tending assemblies. To fill pot tending assemblies with the covering material, there are 4 filling units for pot tending assemblies installed in each potline. Anode cover bath is reprocessed at Crushing Area located between pot rooms. Cells are controlled by the Process Control System SAAT developed in-house by RUSAL.

The following parameters of the potline were considered in the design stage:
- Amperage – 310 kA;
- Current efficiency – 94.5 %;
- Specific gross anode consumption – 553 kg/t Al;
- Specific process power consumption – not more than 13 400 kWh/t Al (here and farther 1 t is specified as 1000 kg);
- Design capacity of the smelter – 278 836 tpy.

After the potline was commissioned in 2009–2012, the following results were achieved:
- Amperage – 320 kA;
- Current efficiency – 94.6 %;
- Specific gross anode consumption – 529.8 kg/t Al;
- Specific process power consumption – 13 760 kWh/t Al;
- Primary aluminum production output – 298 056 tpy.

2. Main Technical Solutions

2.1 Implementation of 100 % Graphitic Cathode Blocks

One of the ways selected to improve the power efficiency of RA-300 cells, in order to achieve the specific energy consumption lower than the designed value, was increasing the graphite content in the cathode blocks from 30 to 100 %. Test results showed that that allows to reduce the cathode voltage drop by ~20 mV (Figure 1).

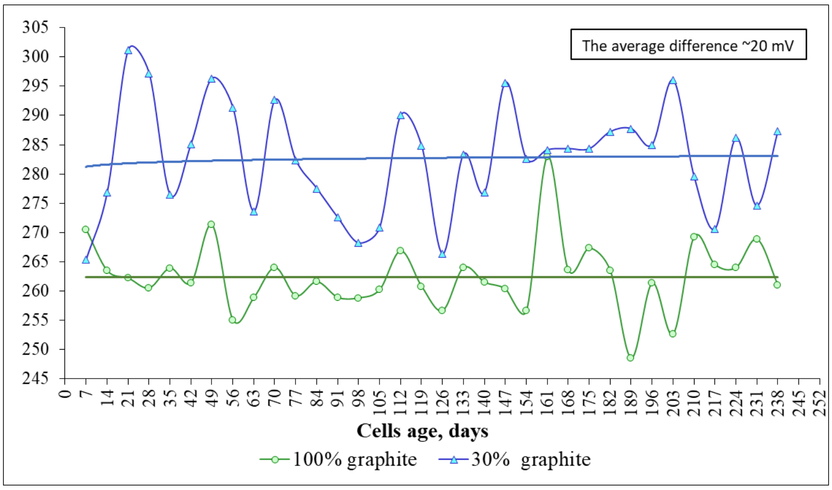

Figure 1. Cathode voltage drop on cells with 100 % and 30 % graphitic cathode blocks.

3. References

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