RUSAL Resource-Saving Technologies

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Abstract

The cost-effective use of resources is a determining factor in reducing the cost of aluminium production. In order to reduce production costs, UC RUSAL develops **no-cost/low-cost** technical solutions as well as **costly and high-cost solutions**. Most of the technical solutions have been tested on prototype pots, many of which have been implemented in RUSAL's potlines.

The company's Energy Conserving Pot Design project uses a strategy focusing on two areas. The first is aimed at improving energy efficiency based on no-cost technical solutions (for example, efficient alumina feeding and voltage control algorithms ensuring a stable reduction process with a low anode-cathode distance, energy-efficient lining designs, etc.), low-cost/costly solutions (for example, elongated anodes with a 4-stud anode rod assembly, steel-copper collector bars, etc.), as well as high-cost technical solutions (for example, energy efficient anode suspension beams, new or retrofitted busbars, etc.). The basic principle of the second area is cost reduction in pot relining through the use of unshaped materials using lignite semi-coke and dry barrier mixes. Unshaped materials can significantly reduce the cost of lining the sub-cathode zone, which enables to recycle at least 80 % of lignite semi-coke.

The above technical solutions are applied for various types of pots in the aluminium smelters in Krasnoyarsk, Sayanogorsk, Bratsk, Novokuznetsk and Irkutsk.

Key words: Cost-effective use of resources, no-cost/low-cost, costly and high-cost technical solutions, unshaped lining materials.

1. Introduction

In the existing pot designs, most of the heat losses fall on the anode cover and the longitudinal side walls (the distribution of the pot heat losses is shown in Figure 1 [1]). This amount of heat losses requires heat recovery based on the pot voltage, which entails increased power consumption and, as a consequence, an increase in aluminium production costs. In this regard, as part of the Energy Conserving Pot Designs project, a design of the cathode has been developed with an increased anode cover depth in order to reduce heat losses from the anode cover, and with an insulated side lining to reduce heat losses from the longitudinal side wall of the pot. Due to the reduction of heat losses, this design results in a more stable reduction process with a lower anode-to-cathode distance, and with lower energy consumption.

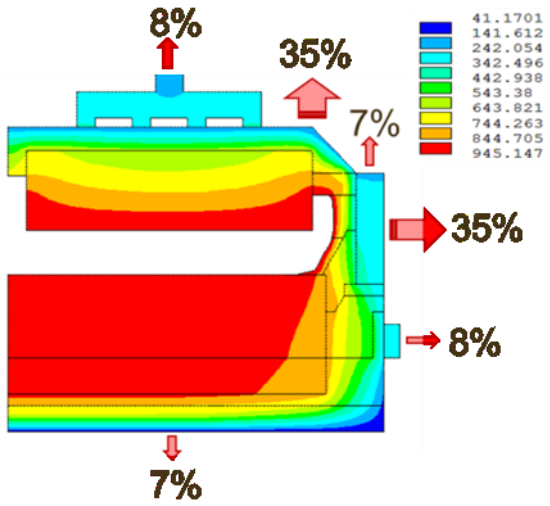

Figure 1. Distribution of heat losses of the pot [1].

To increase the MHD stability through a reduction in the horizontal currents and through a reduction of the cathode voltage drop, a steel-copper collector bar design has been developed and tested in different types of pots. In addition, to ensure a stable reduction process based on continuous monitoring and automatic adjustment of process parameters, the so-called Bath Composition Stabilisation (BCS) algorithm was developed, which reduced variations in the cryolite ratio (CR) and bath temperatures. Also, an algorithm for Automatic Control of the Thermal Balance on the Pot (ACTBP) was developed, which implements the coupled control of a specified voltage and fluoride additives to stabilise the temperature and CR in a specified process range.

Refractory and heat-insulating materials in the form of various-sized bricks are traditionally used as aluminium pot lining. The continuous increase in the cost of energy resources leads to an annual increase in prices for lining materials. In addition, the use of lining materials in the form of bricks is extremely labour intensive since it involves brick laying - an operation whose automation is extremely complicated. The presence of joints between the bricks leads to an increased risk of metal and bath penetrating the cathode shell, and thereby increases the consumption of fluorides. The volume of aluminium production scrap at industrial landfills amounts to tens of millions of tonnes. Of these, about 30 % of the waste comes from spent refractory and thermal insulation materials (spent potlining, or SPL), the recycling of which is a complex process. Up to 40 % of this waste is represented by fluorides, which, along with compounds such as cyanides, which are formed during the reduction of aluminium, are the main cause of the environmental problems in the aluminium industry [2].

One of the possible ways of solving the above-mentioned problems is by using RUSAL's new resource-saving technology that reuses unshaped materials for lining the cathode assembly of pots. A distinctive feature of the technology is the use of a virgin, unshaped lining material (ULM) based on lignite semi-coke [3, 4, 5] and specialised equipment for its installation and compaction.

This article presents the main test results of certain energy-efficient technical solutions that make it possible to reduce power consumption and ensure a stable reduction process without significant capital expenditures. In addition, this article presents the main results of the application of the new unshaped material for lining the cathode assembly and describes the main aspects of the equipment for loading, laying and compacting ULMs.

Currently, the ULM sub-cathode zone is implemented in the cathode assemblies of the pots at the Sayanogorsk and Krasnoyarsk aluminium smelters. Tests are under way to replicate ULMs in other UC RUSAL smelters.

Figure 6. General arrangement of the cathode cross section with ULM.

Figure 7. Cross section with lignite semi-coke in the free state.

5. Conclusions

In Energy Conserving Pot Design project UC RUSAL has developed low energy consumption pots, that reduced specific energy consumption by 550 to 900 kWh/t Al. This was achieved with the use of steel-copper cathode collector bars, which reduced the cathode voltage drop by 60 mV and with new pot control system, which reduced cryolite ratio and bath temperature variations and stabilised thermal and MHD equilibrium of the pots.

The new resource-saving technology for lining the sub-cathode zone of the pots with un-shaped lignite semi-coke-based lining materials reduces the lining cost by 73 % and can be in major part recycled.

6. References

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