Productivity Enhancement at Mahan Aluminium through Amperage Increase

Amit Jha[1], Venkannababu Thalagani[2], Amit Gupta[3], Vilas Tathavadkar[4], Linga Swami[5], Devendra Pathe[6], Abdul Hamid[7], Rakesh Singh[8], Ramesh Chakradhar[9], Gaurav Verma[10], S Sasikumar[11] and Senthil Nath[12]

1. Senior Scientist
2. Scientist
3. Lead Scientist
4. Joint President

Aditya Birla Science and Technology Company (P) Ltd, Navi Mumbai, Maharashtra, India

5. Senior Manager
6. Assistant General Manager
7. Senior General Manager
8. Senior General Manager
9. General Manager
10. Vice President
11. Joint President
12. President

Hindalco Industries Ltd, Mahan Aluminium, Singrauli, India

Corresponding author: amit.jha@adityabirla.com

Abstract

The design solutions are being developed and tested in a stagewise manner to increase the line current while maintaining low specific energy at Mahan Aluminium. Meanwhile, to utilize the full potential of the potroom, the amperage increase strategy is majorly focused towards keeping a constant internal heat generation in the pots, unless limited by magnetohydrodynamic (MHD) instability. Pot sensitivity analysis was performed to assess the MHD stability limits in the pots of different age and design groups. An operational window was developed while keeping a hybrid approach of constant internal heat and anode-cathode distance. The line current was increased from 367 to 374 kA during 2021-2023 while keeping the pots in the operating window. The necessary corrections in pot resistance, anode cover height, metal height, forced cooling etc. were taken either to keep internal heat generation unchanged or to maintain the isotherms at desired locations with increased heat input. The height of the anode was increased to account for increased carbon consumption. The major challenges were power interruptions and the operation of the first-generation old-age pots, which delayed the increase in potline amperage. The operational issues were identified through stringent monitoring of anode cover temperature, anode cover thickness, side ledge, shell temperature, busbar temperatures etc. The frequencies of carbon dust skimming, pot tending, busbar, and basement cleaning were increased. The forced cooling was modulated, and metal height corrections were done for different age groups and the design of the pot. The technical audit frequency was increased to ensure SOP compliance. The rule-of-thumbs established through simulations were followed to keep the pots in the desired operating window. To facilitate a faster current increase, the old pots were replaced while reducing the pot turnaround time.

Keywords: Potroom, Amperage increase, Pot thermal balance, MHD stability, Pot operation.

1. Introduction

Mahan Aluminium shifted the focus towards productivity or amperage increase due to rising LME prices during 2021-22. To increase the amperage, it is very important to identify the present state of the pots. The thermal balance [1, 2] and MHD stability [3-9] of the reduction pots are interrelated and are of utmost importance. An increase in electric current passing through the pot would lead to increased heat generation inside the pot. The increased heat generation should be avoided as much as possible by reducing the anode-to-cathode distance (ACD). The ACD is primarily limited by MHD instability. Beyond the stability limit, an increase in the current will require increased ACD, which should be supported by a set of measures to dissipate the increased heat generated in the pot. Therefore, the first step towards amperage increase should be the assessment of the MHD limit. Based on the ACD limit, a strategy can be devised based on keeping a constant (a) internal heat generation in the pots, (b) a constant ACD, (c) a constant voltage, or (d) a hybrid approach combining all three approaches, while assuming that total plant power cannot be exceeded.

Increasing amperage in a potline may lead to a few challenges w.r.t anode and anode current density, possible loss of current efficiency, process, and operational parameters. Increasing anode current density results in a higher rate of anode consumption, due to which either anode size must be increased, anode change cycle time must be reduced, or both. In case of increased anode current density, carbon dust generation may also increase. The increase in carbon dust generation and MHD instability can reduce the current efficiency, therefore, it becomes a tradeoff between productivity gain and efficiency loss which increases specific energy consumption. The operational issues can be identified through stringent monitoring of anode cover temperature, anode cover thickness, side ledge, shell temperature, busbar temperatures etc. The frequencies of carbon dust skimming, pot tending, busbar, and basement cleaning can be increased. If heat generation in the pot increases, operational parameters such as anode cover, metal height, forced cooling etc. need to be modified. The pots of different age groups and designs may make it a bit tedious to handle and track such corrections. The technical audit frequency should also be increased to ensure compliance with standard operating procedures (SOP). The other challenges such as power interruptions and operation of the old age pots, may delay the amperage increase.

The line current at Mahan smelter was increased from 367 to 374 kA during the period of Jul 2021 to February 2023. The strategy to increase the line current, challenges faced and measures to mitigate the same by the operations team are discussed in the paper.

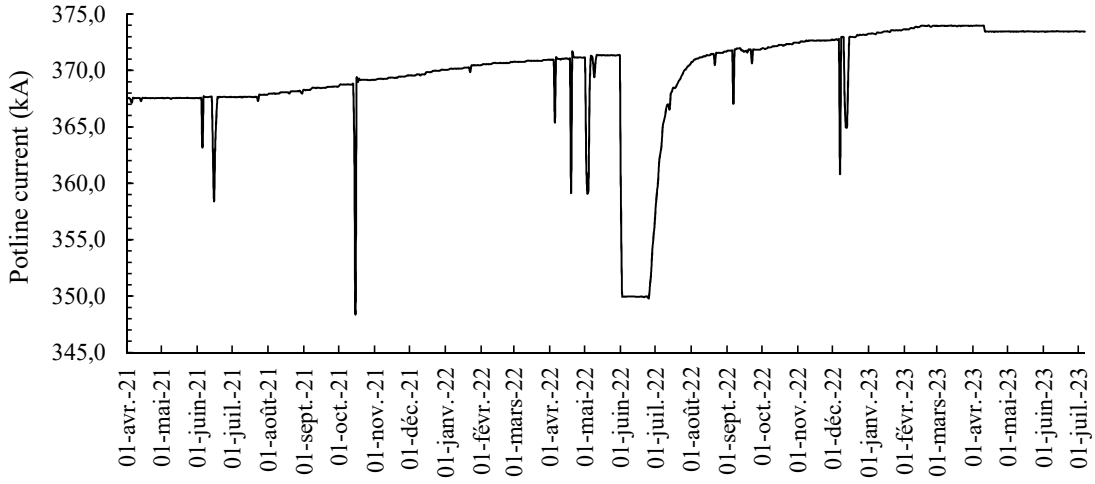

Figure 1. Potline current.

8. Conclusions

The scientific approach to identify the state of the pots, a clear strategy, and potroom execution helped to mitigate the challenges and increase the line amperage by ~7 kA at Mahan smelter without compromising the specific energy consumption. The initial state of the pots was identified through sensitivity analysis and thermal calculations. The computational model was used to predict the thermal balance of the pots at increased amperages and modified parameters. The results from the simulations were used to devise an operating window that acted as a guideline during amperage increase. The internal heat generation was kept constant up to 370 kA and 372 kA in the pots with and without copper inserts, respectively. Beyond 370 kA and 372 kA, a constant ACD approach was used which mainly required corrections in metal height and anode cover thickness.

The forced cooling network (FCN) around the steel shell was modulated smartly to provide extra cooling to the pots without copper insert collector bars. The increased carbon dust skimming frequency and top carbon dust shoveling helped to reduce the mushroom formation. Special measurements were performed which helped to identify and correct the state of the pots while the amperage increased. The ledge thickness only changed slightly with increasing amperage indicating an insignificant deviation in the thermal balance. The major challenges of frequent power interruptions and old-age pots with first-generation design delayed the amperage increase in the potline. However, stringent monitoring prevented unscheduled stoppages of old pots. Additionally, the faster relining with a turnaround time of 4.7 days helped to continue the amperage increase process.

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