Online Shunting of Pots in Hirakud Potline

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Abstract

Hirakud smelter (HKD), a unit of Hindalco Industries Limited is a part of Aditya Birla Group (ABG). Hirakud Aluminium is an integrated aluminium smelting complex that uses GAMI technology and is one of the oldest smelters in India established in 1959. Half of the potline was converted from Søderberg to prebake in 2009 and it has its own inherent challenges in terms of technology and retrofitting the old pots into prebake pots. Aluminium production is a continuous process. Today in modern smelters, pot shutdown and start-up are extremely critical operations, because of the level of energy surrounding the process (electrical and mechanical). As pot stoppage is a very critical activity for productivity as well as for pot life, a sustainable approach is developed to do online shunting of old pots. Various initiatives are applied during day-to-day operation and maintenance practices which help to sustain and maximize the production volume by reducing power disturbances. This paper presents a study of online shunting and its implications in Hirakud smelter.

Keywords: Aluminium reduction cell, Captive power plant, Thermal balance, Online shunting.

1. Introduction

An aluminium smelter potroom can contain hundreds of electrolytic cells or pots that are connected electrically in series. Hirakud smelter has five potlines with 12 rooms comprising 705 pots which are connected in series. Molten aluminium is produced in each pot by Hall-Héroult Process. Optimizing energy use, preventing downtime, and reducing costs of replacement are the key to improve potline performance. Every pot has a life cycle of approximately 2000 days. Critical and high aged pots are the poor performers in the line which drags down the overall current efficiency of the potline. Henceforth, the critical or high-aged pots need to be relined in regular intervals to avoid failure and meet the target production.

In Hirakud smelter on average yearly 140 pots are planned for relining. But previously due to several challenges, it was mandatory to take load reduction (LR) or power outages during planned or unplanned shutdowns. Due to frequent power reduction or power outages, the pot thermal balance gets disturbed, and some severe issues can take place during power resumption like significantly increasing chances of cooling crack formation due to thermal shocks and liquid metal penetration in the cathode blocks. The cathode deterioration may result in increasing the chances of pot failure thus decreasing the pot life.

To compete in the global market in terms of sustainability and higher productivity with quality, each smelter has to work strongly on the probable factors which might appear as major setbacks

in the future. Most modern smelters are adopting innovative approaches to have minimum power disturbances in the potline and have a stable operation. On the other hand, Hirakud had to find a way to shunt the pots in a planned manner with its operating challenges.

2. Operational Challenges in Online Shunting

Power interruptions as well as planned reduction can be difficult to manage due to challenges in the thermal balance of the pot. At reduced internal heat, pots will cool and cause operational difficulties. Additionally, smelters also have pots with different designs and age groups, which react differently to amperage reduction. Hirakud Smelter in its 85 kA potlines has its own limitations and potline current reduction and power outages with old shunting practice of the pots or pot leakages were pulling down current efficiency. Any reduction or outage has a very adverse impact both in the potline and in the thermal power plant KPIs. Any planned or unplanned pot stoppages required 10-20 minutes power reductions. Besides these, the following challenges are persisting in Hirakud 85 kA smelter:

- Hirakud smelter is the oldest end-to-end potline with pre-baked technology operating at 85 kA hence online shunting at full current is extremely risky due to a single connecting point in the riser and heavy sparking during shunting.
- Shunt alignment was a big issue in the potline due to frequent insulation failure of studs and sleeves. The requirement of electric overhead travelling (EOT) was a must for every shunt alignment.
- Due to improper thermal balance and huge heat dissipation from the side shell in 85 kA pots, the ledge profile especially at the conner anodes area gets extended which restricts the lowering of anodes and thereby, lowering pot voltage below 1.5 V becomes extremely difficult during online shunting.
- Also, shunt alignment (Figure 1) during emergency shunting of pots takes around 20-30 min. Even high safety risk is associated with this activity due to heavy sparking.
- Being the oldest smelter, the busbar condition is not suitable enough to accommodate the shock due to power disturbances. In a different location, welding cracks, which are already persisting get propagated due to this shock and thus worsen the conditions.
- Improper busbar ventilation and accumulation of bath beneath the busbar.
- Due to frequent power interruptions, the older pots above 2000 days get severely affected and become prone to failure.

3. Process Challenges

Apart from operational challenges, planned or unplanned shunting both lead to several process abnormalities due to power interruptions. These include thermal shock in cathodes, variation in bath chemistry, high anode effect frequency (AEF), pot instabilities, high cathode voltage drop due to sludge formation, and reduction in pot life. It has been revealed during the pot autopsy that cracks and ratholes (Figure 2) were developed due to thermal shock because of frequent power interruptions.