Experience of Potline Restarts in the TRIMET Group

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https://doi.org/10.71659/icsoba2024-al002

Abstract

Due to high expected power prices, TRIMET Aluminium SE started to reduce the production output in its three German electrolysis sites by around 20 % in 2021. After the start of the war in Ukraine and subsequent gas pipeline explosions in 2022, the German smelters curtailed its production and operated at only 30 % of its capacity. The F-Line in Saint-Jean-de-Maurienne was also curtailed in 2022 due to limited energy availability in France.

To restart the idled potlines with a common best practice, as soon as prices and energy availability would allow, a joined meeting was conducted already in the beginning of 2023, to discuss methodologies, equipment, and team organisation. The teams from the four smelters discussed past experiences and shared concerns about safety and limiting factors for restarts, for example liquid bath generation.

The preparation process and its results are presented in this paper as well as experiences of failed tests, and incidents during restart operations. The four smelters started the ramp-up in the first quarter of 2024 and the results from the first months in the restart environment are discussed.

Keywords: Aluminium reduction potline restart, Electrical restart, Restart methodology, Gas restart, Idled potline.

1. Introduction

As early as 2021, the tense situation on the raw material markets forced primary aluminium production to take a serious step - cutting back production. Primary aluminium production at the Essen, Hamburg and Voerde locations was significantly scaled back. Jobs were not affected by this measure because the existence of the locations is beyond question.

Due to the situation on the global gas market, there was also a gas shortage in Germany in 2022 [1]. TRIMET has therefore decided to reduce production even further in order to save gas by reducing the production of the anode baking furnaces. Further adjustments were subsequently made in September 2022 to reduce the German smelters down to 30 % of their capacity. Also, the French smelter decreased its capacity to 80 % around this time due to the still very tense situation on the energy market.

Preparation is essential for the successful restart of any potline. But preparation already starts with the curtailment, if possible. Daviou et al. have discussed the topic of scheduled curtailment in contrast to sudden shutdown due to an outside event and showed promising results with a planned curtailment [2]. The TRIMET smelters developed strategies on their average potlife on which cells would be restarted – or relined during the curtailment phase.

During the curtailment, cells which were marked as restart pots would not be tapped empty, but rather a layer of aluminium was allowed to stay in the cell to protect the cathode surface from oxidation and exfoliation of the cathode carbon surface. In the Essen smelter the standard procedure was to empty the pots as much as possible and leave a thin protective aluminium layer. Most pots had no solid metal plate left.

2. Common Preparation for Restart Methodology

During a common restart preparation process improvement group meeting initiated by the process improvement group leader, several restart methods were discussed and rated with a Pugh matrix approach. Data was gathered and prepared for the meeting by several of the authors of this paper. The restart methods were researched in press releases, publications in conference proceedings and personal communications with contacts at the individual plants.

2.1 Restart and Start Methods from Literature

We are not the first smelters to restart and others have published their experiences in the last years [2-4]. Table 1a and Table 1b show an overview about the published methods available for preheating of new cells and cells designated for restart.

Table 1a. Overview of used preheating methods in literature. [2], [4-17].

		Short description of method	Sources
New cell start	**Resistor bake**	Anodes are placed on top of resistive carbon material (graphite or coke), which is placed in patches, strips or as a full bed on top of the cathode. Cell is taken into circuit, at target temperature liquid bath is poured into cell and anodes are lifted.	[5-7]
	Dry start	Similar to resistor bake; however, anodes are lowered and cell is taken into circuit and heated by electric arcing until cryolite is molten and no liquid bath is added during the process. Cell reached temperature above 1000 °C for melting process of cryolite.	[7], [11]
	Gas/ oil preheat	Burners are placed into a cavity on top of cathode surface and below anodes. Anodes are locked with clamp as in process. During startup, liquid bath is poured, then the cell is cut in. Cell usually has higher voltage compared to resistor bake during early operations.	[6-8], [12-13], [17]

As in Essen nearly all of the operations are carried out using vehicles, special attention needs to be drawn on the maintenance of these vehicles. To assure that the vehicles can be maintained with one rest day at least once per week without any pot startups was established.

In summary, the ramp-up of potline 3 was successful by this method without any restart-related injuries and an early pot failure rate of restart pot of less than 1 %. The experience gained from 15 cells restarted in potline 1 in order to gather insights was successful.

4. Lessons Learned during Restart

With the four smelters amid an ongoing restart during writing these pages, we can already hint on the following lessons we have learned during restart.

- For a cell with a metal pad, keep a distance between metal plate and underside of anodes to allow for waves of bath and metal to equalize, if the metal is already molten.
- Increase capabilities for liquid bath production in a safe manner.
- Expect cells to fail: Communicate the estimated failure rate within the potroom team and management to set expectations.
- Use the experience from other smelters, if possible. Every smelter had at least one start and will have experienced premature failures and restarts of at least a couple of cells.
- If possible, allow for up to six months to find the necessary personnel and train them.
- Expect metal quality to deteriorate: Fe from stub wash on bath pots, Si from insulation material like mineral wool (which include up to 30 % Si).
- Expect anode failure due to uneven preheating. Especially the removal of anodes with failed bi-clads can become a operational and health and safety issue, if no proper equipment can be used. Cells with 10 % or more anodes with failed clades are very difficult to operate.
- ACD is important during the first eight hours. If one finds anodes without current and anode current distribution is off, increase ACD and add metal, if temperature is deemed too high.
- Expect high temperatures in restarted cells, as sometimes shorting occurs within the cells. Failure of refractory material or cathodes can increase the temperature or reduce the ability to lose heat over the shell, leading to red walls.
- The restart begins during scheduled shutdown, as this action enable certain restart technologies by leaving a metal pad.
- Keeping staff constantly informed about the progress of the work and the refurbishment of the pots, to prepare them for the restart.
- Respect and team spirit by involving staff in restoring the potlines and preparing for the restart of the pots and promoting positive results and the desire to succeed together.

5. Conclusions

The restart of four fully or partially curtailed potlines by the TRIMET team was successfully conducted during the first months of 2024. Additionally, we learned several valuable lessons that **are** shared in this paper. As the restart will continue in 2025, a full recap of the results and data on failure rates, cathode life loss and further results from potlines idled for three or more years will be available by the end of 2025.

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