A Successful 72-hour Sleeping Mode Operation on AP40 Pots in Kitimat Smelter - A Case Study

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Abstract

Kitimat Aluminium Smelter uses AP40 Technology with eight sections of 48 pots in a single pot line configuration with a unique asymmetric gas treatment centre (GTC) configuration requiring a unique "siphon" alumina conveying pathway. In this type of configuration, an interruption in the continuity in alumina supply can disrupt a smelter operating at full capacity over a long period. The 48-pot section experienced a hyper-dense phase system failure on November 9, 2022, causing 48 pots to lose alumina supply abruptly. Initially, the maintenance diagnosis assumed no foreseeable recovery within 72 hours. A contingency plan was activated, keeping the pots in sleeping mode for a few days by lowering the anode beam such that no electrolysis occurs. Currently, limited information exists on alumina disruption and the use of the sleeping mode on a full section. This paper summarizes the successful process steps in Kitimat that prevented pot failure by employing the sleeping mode. Methods, lessons learned, and potline recovery are discussed.

Keywords: Aluminium electrolysis pot sleeping mode, Alumina supply disruption, Contingency plan.

1. Introduction

Aluminium smelting is a continuous process, and any disruption such as a shortage in raw materials (alumina, anodes, or power) or a strike can put a potline at risk of an uncontrolled shutdown. Potline restart is an expensive operation resulting in a loss of revenue and higher costs impacting the financial bottom line. Therefore, any contingency method developed to avert a shutdown can be very valuable for a smelter.

Many publications have been written in the past about the hibernation methodology, in which the anodes are lowered into the metal pad to below two volts, resulting in varying degrees of success depending on the duration of the disruption [1]. With this method, the liquid bath is short-circuited and will cool down until it reaches freezing point.

Over the years, Rio Tinto has developed a sleeping mode methodology where the pot is brought just below the voltage needed to produce aluminium (decomposition voltage), but the anodes are not short-circuited in the metal. By sleeping the pots, the bath temperature does not cool down, and the pot stays alive even if no alumina is added to the pot.

1.1 Sleeping Pot Methodology

The first large-scale use of the sleeping mode method was in 2010 at Laterrière Works, after a major issue with the transmission lines. When one potline had to be shutdown, the second one was restarted without compressed air, as a result there is no alumina feeding. This situation occurred for 8 hours, so the potline was put in sleeping mode to keep the pots alive, and the pots were brought back to normal operation with the return of the compressed air. Every pot was put in sleeping mode for 8 to 12 hours without any pot loss.

Following this event, the sleeping mode method was tested in every smelter of Rio Tinto's Atlantic region, and the method was embedded in the contingency procedures.

In 2021, following many operational problems a sleeping mode trial was performed at the Kitimat smelter for a three-day duration with success. This trial showed that the method may be useful for longer-term contingency problems.

2. Potline Event

The 48-pot section suffered a hyper-dense phase system failure on November 9, 2022, causing 48 pots to suddenly lose alumina supply. Initially, the maintenance diagnosis assumed no foreseeable recovery within 72 hours. As a result, the sleeping mode contingency was initiated.

2.1 Preparation

The Kitimat AP40 superstructure design can hold approximately 18-hours of alumina supply. Therefore, the time was used to prepare the 48-pot section knowing that there was no foreseeable recovery plan within the 18-hour mark.

The first step taken to prepare the affected pots for sleeping mode was to contact other affected areas, such as power operations to ensure they would have available workforce to monitor the voltage and amperage and adjust amperage as needed. Additionally, the gas treatment centre needed to be informed as pots wouldn't be fed with alumina, potentially requiring adjustments to feed rates.

The most crucial step was to ensure that all affected pots (48-pot section) had enough beam movement in both directions. This was achieved through beam raising or metal tapping.

It was also important to lower the bath level in the affected pots and increase the bath levels in unaffected pots to minimize anode pin washing, reduce the risk of cover collapse, and ensure enough bath was available when awakening the pots back to normal pot voltage.

Table 1 shows the workforce organized for the 48-pot section sleeping mode contingency during the preparation phase to ensure that all employees were trained and understood their roles before starting the work.

Another key learning was regarding bath temperatures and selective pots did become quite hot due to no AlF_3 feeding. The decision was made to impose a correction on an individual pot basis based only on hot pots. The AlF_3 feeding was followed and prohibited once the pot was trending under the hot pot threshold.

The main challenges of the awakening phase included the rate of waking the pots and the bath management. Due to the pots going into anode effect upon waking up, the potline voltage fluctuated significantly, creating challenges with adjusting the SURMEC safety voltage gap.

5. Conclusions

Sleeping pot methodology engaged in 48 pot section for 72 hours is success story in BC works – Kitimat (AP40 smelter) after all pots were successfully returned to service without failure. Subsequent autopsies were conducted on few pots from the sleeping pots section, there were no indications of excessive bath attack, no deterioration on preformed blocks or silicon carbide side-wall. Effectively there was no tangible impact on long term performance and pot life evolution with the current lining age of majority of the pots from sleeping pots section have surpassing the forecasted average pot life.

6. References

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