Laterrière Smelter Experience During Low Amperage Operation Due to Rectifier Problems

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Abstract

During the summer of 2023, major breakdown failures at the potline electrical substation forced the Laterrière aluminium smelter to decrease the potline current by 20 kA (from 216 kA to 196 kA) for one month as well as operate at 200 kA for two and a half months before slowly increasing back to the normal amperage over two months. After this event, a root-cause analysis was performed that showed that the cause of the failures was due to a design problem on each rectifier of the substation. Other amperage decreases were necessary to perform a major overhaul on each rectifier. This paper summarizes the events from the point of view of potroom operation, and the lessons learned regarding the technical adjustments and operational targets during the different amperage changes and low amperage operation.

Keywords: Aluminum reduction potline, Low amperage operation, Rectifier maintenance.

1. Introduction

Consistent electrical power is critical for an aluminium smelter and the electrical substation must be reliable to avoid any potlines disturbances. In recent years (decades), many aluminium smelters have increased potline's amperage, which increased the electrical current load on substation equipment including transformers and rectifiers [1].

The Laterrière aluminium smelter is located in the Saguenay region in Quebec, Canada. The smelter has two P-155 potlines of 216 pots each (432 pots total); the annual aluminium production is around 250 kt/a.

The smelter begun to experience problems during the spring of 2022 when an electrical transformer (TR6) failed, which resulted in an amperage reduction of 13 kA (from 216.5 kA to 204 kA) for 10 days in both potlines. A second transformer (TR2) experienced the same kind of failure during the fall of the same year, but without impacting the potline as the external temperature was low enough to allow continuous operation at the normal amperage with a N-1 configuration. This breakdown was repaired in 8 days but showed the fragility of the substation. It was decided to launch a major overhaul project of all the electrical transformers of the substation, making certain to increase on-site the availability of critical spare parts.

However, in June 2023, during a heat wave, two rectifiers (R8B and R3A) failed in a short time interval which forced both potlines to operate at 196 kA. Inspection of the failure draw attention to the impact of the high operating temperature inside the rectifiers, which caused diodes failure. Both rectifiers were repaired within a month but, to minimize the risk of another rectifier breakdown, the amperage was limited to 200 kA for another 75 days. During the fall of 2023, during the preparation of the rectifier's major overhaul, the amperage target of the potlines was

increased slowly (Figure 1) by controlling the internal temperature inside the rectifiers - which is strongly dependent on the external ambient temperature that was cooling down during that period.

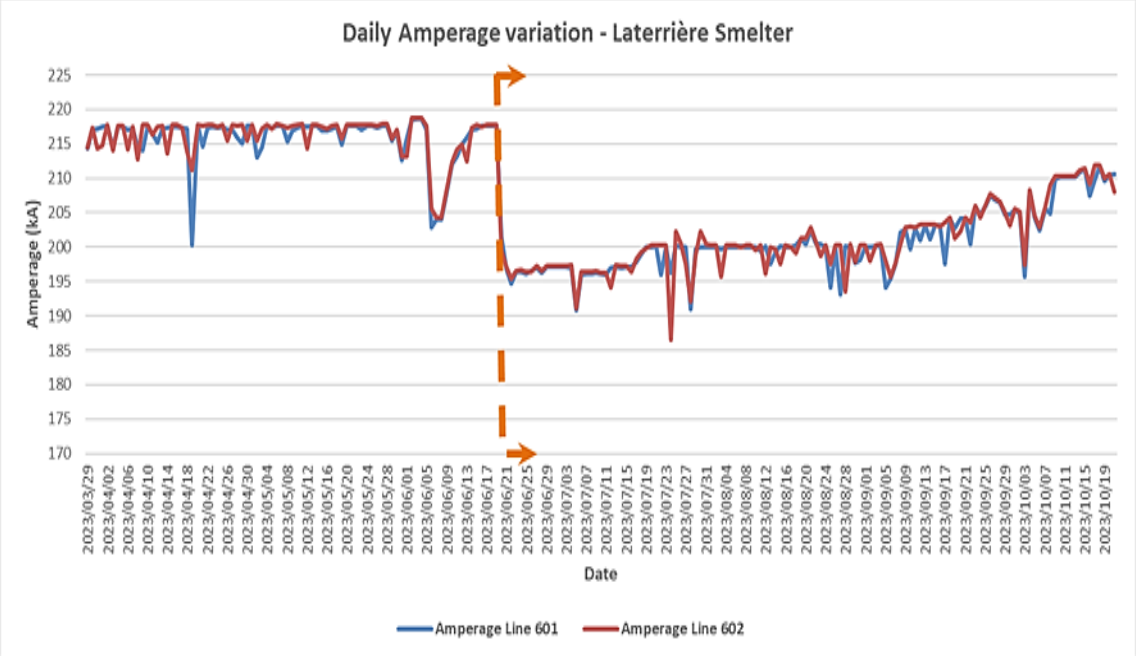

Figure 1. Daily amperage of the two potlines.

The amperage was not brought back to the initial target because the major overhaul of the rectifiers required frequent amperage drops to 195 kA.

This paper explains what was accomplished to operate the potlines during this period and to be ready for any further amperage drops (risk to operate at 185 or 195 kA, in case of another rectifier breakdown failure). A complete review of the emergency response plan was also conducted.

2. Substation

The investigation of the breakdown failures of the two rectifiers demonstrated that operation temperature inside the equipment was above the maximum recommended by the supplier. An underperforming cooling system of the units was found to be the root cause of the diode failures in the equipment (Figure 2).

Each half-rectifier has 6 wheels of 12 diodes (total 72) and the substation has 16 half-rectifiers for a total of 1152 diodes to replace. It was found during the inspection that the break-down failure of an old diode impacts the life of a new diode. The project had to improve the air circulation of the 16 half-rectifiers. The illustration of a rectifier and its 6 diodes wheels is presented in Figure 3.

The last time this equipment was used, was during the restart of Potline 1 in 2010, following a problem with the electrical transmission line. It was installed when the electrical current in Potline 1 was completely stopped (0 voltage on the potline).

A Kaïzen (Continuous Improvement philosophy) was conducted to make certain the emergency response plan was adequate in case of need to stop a group of pots. Several activities were completed:

- A complete review of the procedures; some flaws were identified for the electrical safety of the people working to install the bridge.
- A complete review of the maintenance plan and its execution as the bridge was not maintained for many years.
- Procurement of missing parts of the bridge and equipment; a special cabinet was dedicated to store the bridge parts and equipment.
- Development of a document explaining the roles and responsibilities of each employee involved.
- Testing of the motion of the moving bridge part to ensure the correct motion and the correct grabbing point for the crane to manipulate it.
- SMED (Single Minute Exchange of Dye) activity to reduce as much as possible the installation time.

The maintenance of the by-pass bridge was put back in the plant maintenance calendar and the emergency response plan was modified with all of the changes.

7. Conclusions

The Laterrière aluminium smelter was able to operate successfully after major extended amperage decreases caused by two potline rectifier breakdown failures. After the upset, the process was stabilized, and pot production was above expectations despite excessive ledges found in the corners of pots. Due to the fragility of the electrical equipment, many actions were taken to improve the emergency response plan and preparations for any further amperage decreases with minimum impact on potline performance.

8. References

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