Reducing Perfluorocarbon Generation at Tomago Aluminium Company through Improved Anode Effect Treatment

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Abstract

Tomago Aluminium Company (TAC), the largest aluminium smelter in Australia, recognized a need to reduce perfluorocarbon (PFC) emissions to meet their decarbonization targets. The existing anode effect treatment (AET) settings reflected the historical methodology of progressively deeper "loops" to squeeze/un-squeeze the anode-cathode distance (ACD) and pump the displaced bath into and out of the channels and feed zones. The anode effect treatment (AET) efficiency was found to be lower than comparable smelters. After careful data analysis, a 3-stage improvement process was defined: standardization across three potlines, refinement of the existing loop settings, and finally re-configuration of the loops. Parameters were reviewed, risk assessed and trialled progressively through each of the three stages over a four-month period. The trials demonstrated a statistically significant, 50 % reduction in estimated PFC emissions by reducing the anode effect duration (AED) and without impacting anode effect frequency (AEF). The new settings were deployed on all three potlines at end of 2023 and the 50 % PFC reduction has been observed and sustained. This paper describes the collaboration between TAC and the RTA technical teams (in Australia, France and Canada) to develop an experimental process that achieved this significant milestone for TAC.

Keywords: Anode effect frequency (AEF), Anode effect treatment (AET), Anode-cathode distance (ACD), Perfluorocarbon (PFC) emissions, Decarbonization.

1. Introduction: Data Analysis of TAC Estimated PFC Generation in All 3 Potlines

Tomago Aluminium Company (TAC), the largest aluminium smelter in Australia, recognized a need to reduce perfluorocarbon (PFC) emissions to meet their decarbonization targets. The existing anode effect treatment (AET) settings reflected the historical methodology of progressively deeper "loops" to squeeze/un-squeeze the anode-cathode distance (ACD) and pump the displaced bath into and out of the channels and feed zones. The anode effect treatment (AET) efficiency was found to be lower than comparable smelters.

TAC data was analysed to understand the contributors to high estimated PFC generation. Following were the observations:

- 66 % of total PFC generated was from manually treated anode effects.
- 33 % of total PFC generated was from successfully treated (Auto) anode effects.
- 1 % of total PFC generated was from new cells.

Further analysis of AET squelch sequences was carried out to increase the Successful AET rate and reduce the Manual AET rate and hence improve PFC generation. Physical reasons of AEF and multiple AE were out of scope for this work. Observations of data analysis guided the work to be in two categories as explained in following sub-sections.

1.1 Successfully Treated (Auto) Anode Effects

Data analysis was done to understand the efficiency of AET for successfully treated anode effects. Following were the observations:

- Table 1 clearly shows that L2 had higher (62 %) successful AET in Loop 0 & 1 compared to L1 and L3 (50 %)
- Rate of successful AET on loops 0 and 1 are in general lower when compared with similar smelters.

Table 1. Percentage of successful AET in different loops for all three lines.

	All Values in %		
AET Loop Sequence	Line 1	Line 2	Line 3
0	27	33	22
1	23	29	26
2	20	18	23
3	15	11	16
4	9	6	8
5	6	3	5
Total	100	100	100

These observations prompted investigation of what was different in L2 and to maximise successful AET in loops 0 and 1.

1.2 Manual AET (Including Failed Auto Treatment) Anode Effects

The reasons/causes for Manual Anode effects were investigated, with the following observations:

- Auto AET failed and declaration of impossible anode effect was the major contributor.
- Recent AE declaration causing impossible AE was 2nd biggest contributor.

These observations prompted investigation of each step (loop) of the automatic AET to understand reasons for failure. Multiple anode effect causes were largely out of scope for this work, though it was considered that some AEs might be reappearing because they were not treated effectively the first time.

2. Existing AET Configuration

The existing settings for AET in ALPSYS® reflected the historical methodology of progressively deeper "loops" to squeeze/un-squeeze the ACD and pump the displaced bath into and out of the channels and feed zones:

- Progressively deeper loops (preliminary + 5 elementary loops).
- Short duration "hold" with the ACD squeezed.
- Voltage checks for success only when each loop was completed with the ACD un-squeezed.

3. The success of the Stage 3 trial using several work sections and covering all potlines illustrates the value and power of large trials to prove (or disprove) an opportunity quickly. This success was highly significant and was assessed within a single anode rota enabling us to get the maximum benefit quickly.
4. This trial has re – confirmed the findings since then that squeezing ACD and holding is more effective than progressively deeper "loops" to squeeze/un-squeeze the ACD and pump the displaced bath into and out of the channels and feed zones
5. The 3 stages of this improvement work have demonstrated that there is significant risk of AE conditions returning if up orders are processed either too soon after the down orders, or at too fast a rate when trying to recover the cell to target resistance. Minimal up orders during AE treatment are considered best practice, and the rate of adjustment (rehabilitation) needs to be carefully managed once the cell voltage drops.

9. References

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