Enriched Alumina Silos: What Is Their Purpose, Are They Still Required?

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Abstract

The majority of prebake aluminium smelters have enriched alumina silos which provide a buffer between the potline's Gas Treatment Centre (GTC) and the pots themselves. The enriched alumina silos typically store between 300 and 1000 tonnes of enriched alumina and for many smelters the silo level is kept reasonably constant > 80 % over the life of the smelter, so effectively the alumina in the silo is part of the smelters working capital. Many smelter operators may see this buffer as a safety net in their alumina silo, however this paper will demonstrate that potentially this so-called buffer is both, unnecessary and an ongoing risk.

Keywords: Gas treatment center, Fume Treatment Centre, Gaseous fluoride emission, fluoride mass balance, AlF_3 chemistry control, Silo fine segregation.

1. Introduction

Since the late 1880's the world's industrial aluminium production has been using Hall–Héroult process which reduces alumina to molten aluminium in an electrolytic reduction cell or "pot" according to Equation (1).

$$2Al_2O_3 + 3C = 4Al + 3CO_2 \qquad (1)$$

Regardless of the pot technology supplier, vintage or amperage, the overall basic concept of the reduction cell has not changed in over 120 years, except for the anode which has progressively changed from the traditional Søderberg or self-baking anode technology to prebake anode technology for most of the world's aluminium production today.

Whether it be Søderberg or prebake aluminium reduction cell technology, all aluminium pots have one thing in common in that they rely on a near constant supply of alumina to ensure the electrolyte alumina concentration will not drop to less than approximately 1.5 % to generate an anode effect. What has changed significantly over the last 50 years is the way in which the alumina is transported from the fresh alumina silos to the electrolyte. The most notable change being the introduction of the dry Gas Treatment Centre (GTC) used to capture the hydrogen fluoride and dust emissions drafted from the pots, using fresh alumina as the reactant and adsorption material. The spent or enriched fluorinated alumina is then extracted from the GTC in a continuous process and transported to a storage silo, often called the enriched alumina or secondary alumina buffer silo.

From the enriched alumina silo, the alumina is transported to the pots (Figure 1) using one of various technologies available to both transport the enriched alumina and feed the pots either using two separate systems typical of older plants or a more modern combined system.

The function of the GTC is both environmental as well as cost saving as hydrogen fluoride is both harmful to the environment as well costly to replace in the pots with aluminium fluoride at US$ 1000 to US$ 1500 per tonne.

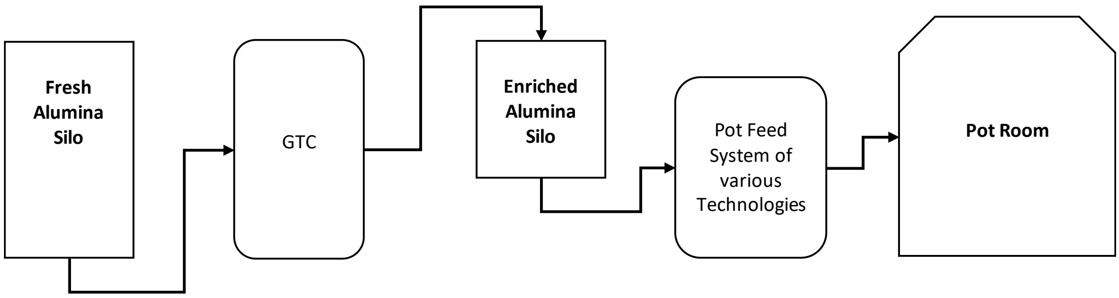

Figure 1. Typical alumina storage, scrubbing and pot feed flow to a potroom.

2. A Look at Various Pot Feed System Technologies in Use Today

One of the older pot feed systems that is still in limited use today for the end-to-end pot technologies is the side-break truck-fed technology (Figure 2). This simplistic pot feed system does not require any storage on the pot, nor feeder system in the pot with the alumina transported directly from the GTC enriched alumina silo to the large side channel typically three times a day. The enriched alumina is then broken into the pot where it progressively dissolves in the electrolyte over the following 6 to 8 h. The enriched alumina silo provides a storage buffer between continuous alumina supply from the GTC and the trucks feeding the potline. Prior to the common use of GTC's in aluminium smelting, the alumna was collected from the main storage facility and fed to the pots as fresh alumina.

Figure 2. Alumina feeding by truck to the side of a Søderberg pot [1].

Some of the original side break potlines, such as Kurri Kurri Potline 1 in Australia were later converted to truck feed to an alumina hopper in pot superstructure (Figure 3); from there the enriched alumina was fed to the electrolyte via a typical break and feed system common in modern pot technology. Regardless where the alumina truck feeds the alumina into the pot, in both cases the enriched alumina silo or fresh alumina silos are used as a buffer to allow for the trucks intermittent coming and going.

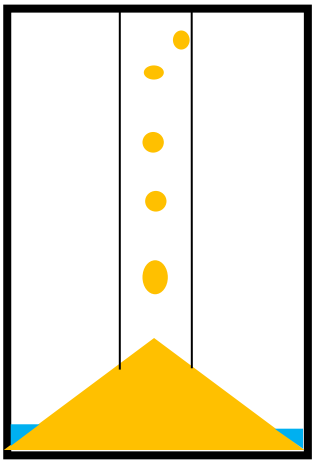

Figure 14. Enriched alumina silo with level reduction chute to enable silos to be either by-passed or reduce their working inventory but at the same time minimize fines build up on the sides.

9. Conclusions

Enriched alumna buffer silos once performed a critical role in providing a two- to three-day buffer between a GTC and less reliable conveying systems and manual mechanical pot feed systems such as PTMs and trucks. The down side of these buffers is the capital and operating capital cost and fines segregation which make slugs of fines enter the potroom and cause high numbers of anode effects. However, in spite of the rollout of pneumatic pot feed systems with improved reliability and redundancy of GTC alumina supply systems, the willingness to basically eliminate the enriched silos has been very limited, even when project costs are under pressure.

Aluminium potline operators obviously have comfort in large buffers, however for most of potlines discussed in this paper, this comfort comes at a cost that is hard to justify and in some cases the comfort is overestimated due to cycling. Even when older potlines have their pot feed systems and GTCs modernized, the smelters keep the enriched silo capacity and do not fully take advantage of possible cost reduction. Aluminium industry as a whole is struggling with falling LME aluminium prices, rising alumina prices, rising coke prices, rising power prices, etc.; it would therefore appear that potentially significant cost reduction of enriched alumina silos needs to be further investigated with the potential benefit of a reduction of anode effects.

10. References

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