A practical, cost-effective solution to processing sodium reduction skimming station residue

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Abstract

Sodium removal technology is increasingly being employed to lower sodium and other alkali metals in primary hot metal direct from the reduction potlines, to meet ever increasing demands of customers. As with most processes designed to remove the non-desired species, there is a sodium skimming waste stream; and this waste stream needs to be managed away from traditional landfills in an increasingly stringent regulatory environment, combined with an on-going tight LME market. This paper describes how Emirates Aluminium (EMAL, also known as EGA Al Taweelah), an operating subsidiary of Emirates Global Aluminium (EGA), used existing plant and resources to successfully treat and dispose of 100 % of its sodium skimming waste stream within the confines of the smelter.

Keywords: DX pot technology; TAC residue; SRSS skimming material; bath processing.

1. Background

The progressive increase in aluminium smelter current efficiency over recent decades has had the side effect of increasing the concentration of sodium and other alkali metals in primary aluminium. At the same time, customers are demanding aluminium with tighter specifications on impurities. Smelter operators are increasingly employing the in-crucible alkali treatment process, using aluminium fluoride as the reactant to precipitate out sodium and other alkali metals. At EMAL, removal of the unwanted alkali is undertaken at a Sodium Removal Skimming Station (SRSS), yielding a SRSS residue waste stream.

At 1.3 Mtpa (mega tonnes per annum) of primary aluminium production, EMAL is one of the world's largest smelters and as such produces an equivalently large amount of SRSS residue (over 4 500 tpa), some of which is shown in Figure1. Additionally, EMAL operates under strict environmental conditions that significantly limit landfilling of process waste streams. The traditional off-site dross treatment process was costly, due to the low metallic content of the SRSS residue.

2. Identifying the challenge

Within six months of EMAL Phase I achieving full production, at approximately 750 000 tpa, EMAL had generated approximately 2 800 t of SRSS residue and the costly off-site treatment seemed to be the only option. The process diagram for SRSS treatment is shown in Figure 2.

Figure 1. SRSS residue, June 2011.

Unlike normal Casthouse dross, EMAL's SRSS residue has lower metallic content (approximately 40 % to 45 %), which increased the treatment costs. In 2011, the treatment costs were quoted at US$ 800 per tonne of recovered metal. For EMAL Phase I and Phase II, the combined annual cost was estimated at US$ 3.6 million per year – effectively adding US$ 2.75 per tonne of aluminium to EMAL's operating costs in a tough LME environment. Additionally, there was the economic loss of the non-metallic contents, namely aluminium fluoride (8 %), alumina (25 %) and the remaining bath material.

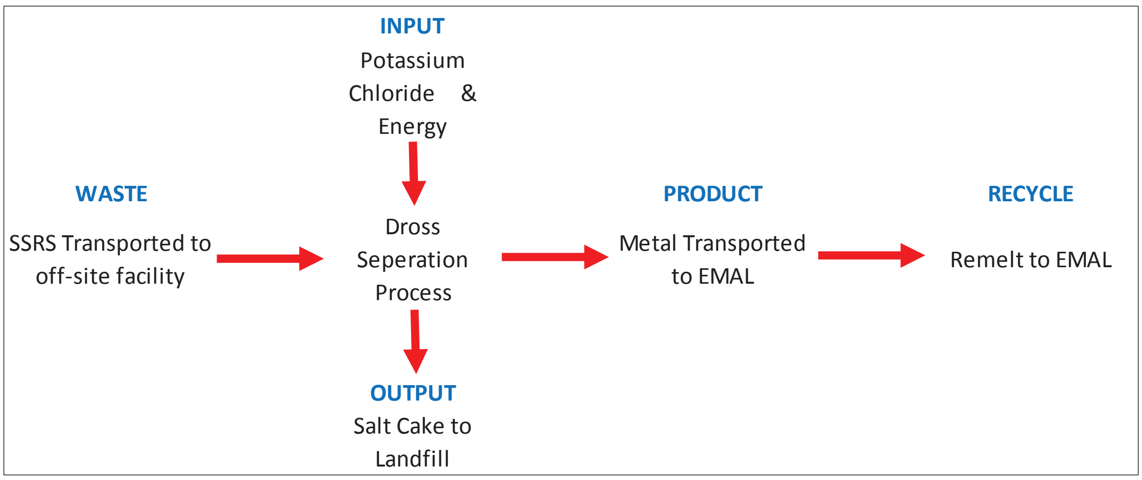

Figure 2. EMAL dross treatment process.

EMAL conducted two unsuccessful trials for processing the residue on the site. The first involved processing the material via the Bath Plant Facility (BPF), which caused numerous blockages; and the second involved adding the material directly to the pots, where the volume of material was considered too much for the teams to handle (and too dusty).

3. What could be done on site?

EMAL's BPF uses autonomous air swept technology with an air flow of approximately 90 000 Nm^3/h. The initial trials attempted to process the material with cavity-scoop material. However, the flaky metallic pieces jammed the valves prior to the airlift, as well as the vibrating screen. Typical air swept discharge BPF technology utilises autonomous grinding to reduce the particle size of the recycled anode cover and other bath-based process materials to a small enough size for the particle to be suspended in the gas stream and swept out of the mill. After a period of time, typically 8 hours at EMAL, the mill is stopped and the uncrushable residue in the mill is ejected. The uncrushable residue (about 1 % of the total feed) typically comprises iron, aluminium and carbon, with some bath material.

EMAL determined that, for the process to be successful, the flaky aluminium pieces (Figure 3) needed to remain in the mill and be ejected in batch mode. To do this, the plant would be run exclusively using the skip lift, which feeds the mill directly, thus avoiding mixing with other material. The method of processing is also fairly different to normal bath processing, as the mill residue will make up 40 % to 45 % of the total feed and will be the desired product. Conversely, the significantly lower valued non-metallics are swept through to the crushed bath silo.

Figure 3. Skip of SRSS residue ready to be fed into the Phase I Bath Plant Facility.

The milling process reduces the non-metallic components to sub 500 μm, which is then suspended in the gas stream and swept out of the mill. To prevent the aluminium pieces being carried up with the bath, the airflow rate had to be reduced to the point that the metal remained in the mill, but the non-metallics were able to drift free. Through a series of trials, it was determined that a gas flow of 40 000 Nm^3/h achieved this goal, requiring only minor changes to plant operations.

4. Separated metallic residue from the mill

The remaining material in the mill (Figure 4) is then discharged via the usual process to produce approximately 4 t of "Corn Flake"-sized metallic particles of aluminium (Figure 5).

Figure 4. Mill residue, prior to being ejected.

Figure 5. Metallic aluminium residue from the mill.

The non-metallic components pass through to the crushed bath silo, which is part of the anode cover circuit. As approximately 40 % to 45 % of the material is metallic, the mill is fed in small 20 t batches to prevent the mill being over filled, which would otherwise make a clean (non-spillage) discharge cycle difficult to achieve.

5. Modifications to the Bath Plant Facility

All changes to the plant were limited to the Process Control System (SCADA). With the support of the maintenance team, a new operational mode was generated for processing the SRSS material. When starting the plant, the operator selects SRSS mode, which automatically sets the correct fan speed, input location and destination silo.

6. Financial impacts

The on-site treatment process is advantageous as the non-metallic components, including aluminium fluoride (8 %), are recovered. This is a significant benefit. A comparison of the on-site and off-site treatment costs is given in Table 1. As the figures confirm, the benefit from on-site processing is US$ 2 million greater than from off-site processing.

Table 1. Cost comparison in US$ million, year 2014 (negative numbers are costs, positive numbers are benefits).

Annualised off-site treatment costs	
Quoted off-site conventional dross processing	- 1.4
Estimated metal recovery	3.1
Net benefit for off-site disposal	**1.7**
Annualised on-site treatment costs*	
Estimated on-site treatment costs	- 0.1
Estimated recovery value of aluminium	3.4
Estimated recovery value of aluminium flouride	0.4
Net benefit for on-site disposal	**3.7**
Difference between on-site and off-site treatment	**2.0**

*No value has been factored in for the recovered alumina or bath.

7. Project milestones

- Trials began in August 2011.
- The recycling process was introduced as routine by November 2011.
- By mid-2012, the potline courtyard stockpile was completely reprocessed (Figure 6).
- By the end of 2012, over 7 000 t of SRSS had been processed.
- By mid-2014, when Potline 3 achieved full production, annual production of SSRS increased from 2 800 tpa to 4 500 tpa.

Figure 6. Cleaned-up court-yard.

8. Environmental impacts

The off-site dross salt treatment process would produce up to 3 100 tpa of landfill waste and would require between 250 and 300 extra truck movements on the UAE roads per year. Every truck removed from the roads reduces pollution and congestion; and improves road safety.

9. Potential extension to other waste streams

EMAL has briefly considered processing non-magnesium dross waste streams from the Casthouse. However, at this time EMAL needs to reserve bath plant operating capacity for Potline 3 as the Potline 3 Bath Plant uses gravity discharge technology and is not suitable for this process.

10. Conclusion

Using lateral, out-of-the-box thinking and deploying only the plant and human resources on site, EMAL has found a cost-effective solution to processing sodium skimming residue waste. The result is a saving of US$ 2 million per year (equivalent to a reduction of 1.5 US$/t Al in operating costs, with the added benefits of eliminating landfill and the removal of more than 250 trucks from local roads each year.