The Effect of Alumina Attrition Index on Breakage in Transport and Handling

Astrid J. Meyer[1], Julius Angwafor[2], Ann Kristin Prytz[3], Erik Tveten[4] and Are Dyrøy[1]
1. Principal Engineer
3. Laboratory Supervisor
4. Senior Engineer
Hydro Aluminium, Porsgrunn, Norway
2. Area Manager, Hydro Aluminium Neuss, Germany
Corresponding author: Astrid.Johanne.Meyer@hydro.com

Abstract

Particle strength is one of the important quality characteristics for alumina and is influencing the breakage and generation of fines during transport and handling. The industrial standard for defining the breakage potential is the "Attrition Index" measured with the ISO 17500 method. However, there are some limitations with the analytical method; it is known to be a "rough" method that may not reflect the breakage in applied conveying systems in a smelter; it does not give any information of the breakage products; and the inter-laboratory reproducibility of the method is poor. To obtain more knowledge about the correlation between the Attrition Index value and the breakage in a smelter, extensive sampling has been carried out in Neuss smelter involving 3 different alumina sources with medium and high attrition indexes. Analyses of Particle Size Distribution have been carried out for both primary and secondary alumina and the actual smelter attrition has been compared with the Attrition Index.

Keywords: Alumina Attrition Index, alumina handling, alumina breakage, alumina quality.

1. Introduction

The Particle Size Distribution (PSD) and the Attrition Index (AI) are some of the important parameters for alumina quality. High levels of fines (-45 µm) and the super-fines (-20 µm) are known to negatively influence both transport and handling, gas scrubbing and pot room performance; for example, anode effect frequency, sludging and instability. The result can be poor pot line performance (loss of current efficiency and increased emissions. Hence, most smelters prefer an Attrition Index as low as possible.

Many Smelter Grade Alumina (SGA) producers include the Attrition Index parameter in the shipment Certificate of Analyses (CoA). The parameter is a measure of the alumina's potential breakdown during transport and handling and is defined as the change in the +45 µm (or +325 mesh) fraction. The most common method to determine alumina breakage is the Forsythe-Hertwig Attrition Index ISO 17500 method.

There are some challenges related to the parameter:

- The Forsythe-Hertwig method is known to handle the alumina roughly, i.e. the AI may be an over-estimate when it comes to the resulting increase of fines in a smelter.
- The result is influenced by the initial fines content in the primary alumina
- The size and number of the breakage products are not considered.
- The inter-laboratory reproducibility for this method is relatively poor. It is hence necessary to carry out Attrition Index analyses of different alumina sources in the same laboratory in order to compare values between different suppliers.

The above points give challenges when it comes to understanding the correlations between the Attrition Index reported on the CoA and the effect this parameter has on the smelter performance of the alumina source.

2. Experimental

Neuss smelter is used to handling different alumina sources. In this study, we have focused on three aluminas with different Attrition Indexes and studied the resulting fines content at different locations throughout the handling systems. Table 1 below outlines the size fractions and the measured Attrition Index of the primary alumina. The values are based on internal analyses of shipment samples. As shown in the table, the aluminas have significantly different Attrition Indexes and it could therefore be expected that alumina C would lead to more fines generation than alumina A and B.

Table 1. Particle Size Distribution and Attrition Index of the primary alumina sources.

	+150 µm (%)	-45 µm (%)	-20 µm (%)	Attrition Index (%)
Alumina A	1.4	10.2	1.76	12.4
Alumina B	2.6	10.4	1.85	23.2
Alumina C	0.1	8.1	0.82	46.0

It should be noted that the results for alumina B are average values of analyses of several shipment samples of this alumina. The samples were from 2016-2017 but not the exact shipments in the study. However, they do represent the quality of this source.

Alumina A was used in both lines in Neuss for a time period of approximately 2 months. The shipment was mixed with shipments from alumina B in transport and handling during this time, hence the results do not give a clear picture of the performance of alumina A and may not represent the breakage with pure alumina A. Thereafter, the aluminas B and C were separated and run in parallel in the two lines simultaneously (alumina B in line 1 and alumina C in line 2) for one and a half month. This period has been referred to as the “Test Period” and shown with vertical lines in the result figures. The alumina sources have been separated in different storage silos and mixing of the aluminas has been limited. The purity of the alumina regarding source has been confirmed by trace elements and phase analyses.

2.1. Alumina Handling Systems and Operation

The alumina is shipped to the port in Rotterdam, then further to Neuss harbour, where it is placed in the main storage, consisting of 10 storage silos. In the conveying loop, various equipment is used. Belt conveyers, air lifts, air slides, vehicles, vacuum unloader and dense phase pneumatic conveying. Of these handling types, the most aggressive to the alumina, when concerning particle breakage, is the high pressure/high energy pneumatic systems, i.e., air lifts and dense phase systems.

Although conveying systems are of the same type, one knows by experience that not any systems will operate and be 100 % the same. Hence the outcome can often be different from seemingly equal systems.

2.2. Alumina Sampling

The shipment samples delivered by the producers were used as primary alumina reference samples. In addition, the following sampling program was followed:

the rougher nature (dense/dilute pneumatic conveying). And also, distinctly include return dust from the electrolysis when applying Attrition Index calculation as "smelter" attrition.

5. Conclusions

Particle strength is one of the important alumina properties and breakage into fine material is known to have significant negative effects on smelter operation. However, both this study and literature references show that the smelter will not get sufficient information based on the CoA with regards to the expected content of fines and superfines at cell feeding. Smelters need to know their own systems and how the alumina sources they use behave in those specific systems in order to predict the resulting fines generation and to evaluate the suitability of the different alumina sources.

The results show a good agreement between the Attrition Index and the smelter breakage for alumina source A and B. For alumina source C, the fines content is significantly lower than expected considering the Attrition Index measured in the laboratory.

It is also shown that the different transport systems give a difference in fines content. It is suggested that as much 2.5 – 7.5 % can be returned dust from cells, but the rest is either crushing or segregation, and since the samples are taken daily or more over a period of time, the increase in fines are most likely to be degradation.

Alumina sourcing should consider the conveying and handling systems in the respective smelter scheduled to receive the alumina. In a greenfield smelter, the handling systems should be standardized and preferably mechanical based or air slide based.

Until a better method is developed, the standard method attrition index should be followed and reported. The fines and breakage are problematic and should be avoided.

6. Acknowledgement

The authors would like to thank Andreas Steube, Christian Lintzen and Wolfgang Schaedel for their contribution regarding data and information, Herbert Appelstiel for sampling as well as Marco Nierfeld and Kristin Sundby for their contribution regarding analyses.

7. References

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