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IMPROVEMENTS IN SMELTER GRADE ALUMINA QUALITY AT CLARENDON ALUMINA WORKS

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Abstract

Alcoa's Clarendon Alumina Works recorded a significant improvement in its smelter grade alumina, SGA, quality. This marked improvement came about as a result of changes in green liquor filtration technology and process management in precipitation. This paper discusses the impact that these changes had on iron, calcia, titanium, silica and soda in SGA.

Introduction

Alcoa's Clarendon Alumina Works, CAW, located in South Central Jamaica, is a low temperature digestion plant with an annual production capacity of approximately 1.4 million tonnes SGA. The refinery is ISO 9001:2008 certified.

Since 2007 the quality of the alumina produced at CAW has made progressive improvement as measured by the Customer Satisfaction Index (CSI). The CSI is the metric that measures the refinery's ability to meet critical parameters required by the smelter customers. For Clarendon these parameters include iron oxide (Fe_2O_3), silica (SiO_2), sodium oxide (Na_2O) and calcia (CaO). These parameters are affected by the quality of the liquor sent to precipitation and operating practices. At the beginning of 2007 the CSI averaged 55%. Following the commissioning of improved technologies and improvement in process management systems, the CSI increased to an average 92% in 2009. See Figure 1. Table 1 show the trend of the alumina quality parameters in SGA for the period 2006 – 2009.

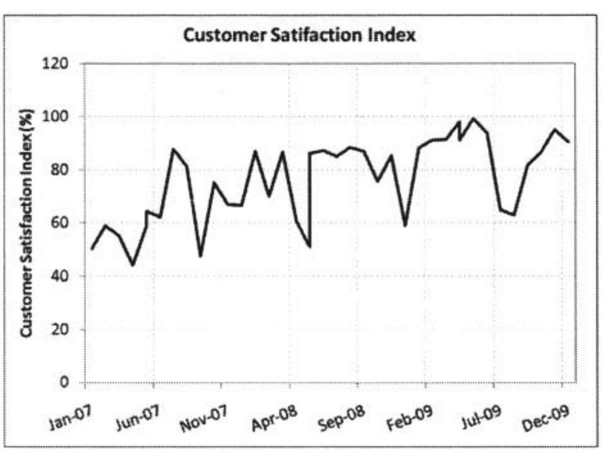

Figure 1: Customer Satisfaction Index 2007 - 2009

Parameter	2006	2007	2008	2009
% Fe_2O_3	0.019	0.010	0.008	0.009
% SiO_2	0.017	0.017	0.016	0.014
% Na_2O	0.45	0.45	0.40	0.43
% CaO	0.057	0.054	0.051	0.050
% TiO_2	0.002	0.002	0.001	0.001

Table 1: CAW Alumina Quality 2006 – 2009

Iron oxide (Fe_2O_3), titanium (TiO_2) and calcia (CaO) all showed a step reduction which was directly related to the commissioning of the high pressure [1]Diastar filters. This resulted in a significant drop in the particulates in the liquor sent to the precipitation circuit. Further, improvement in the filtration process control and monitoring minimized deviations and sustained gains.

In precipitation, strategic changes in process management and hydrate classification using hydro-cyclones were the main contributors to the improvement in silica and soda levels in SGA.

Improvement in Fe_2O_3, CaO and TiO_2

The Effects of High Pressure Diastar Filters

Since the construction of the refinery in the early 1970s the plant has employed the use of sand filtration technology to remove suspended particles from the liquor being fed to the precipitation circuit. In this process the liquor is filtered by gravity through a bed of suitably sized sand and the filtrate fed to the precipitation stage.

There were several issues associated with sand filters that resulted in high particulates in filtrate. These included:

- Frequent screen ruptures and sand leakages
- Changes in the particle size distribution of the sand bed over the life cycle of the filter

- No efficient way of flushing out the mud entrained in the sand bed during the filtration cycle.

As a consequence of aforementioned, the operations experienced high variability in the control of iron oxide, titanium oxide and calcia in SGA.

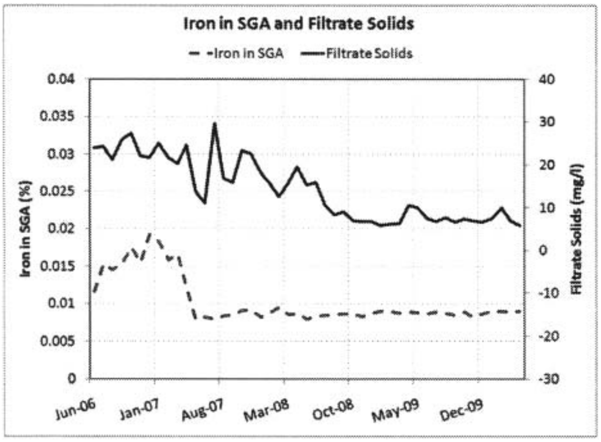

Figure 2: Iron in SGA and Filtrate solids 2006 – 2009

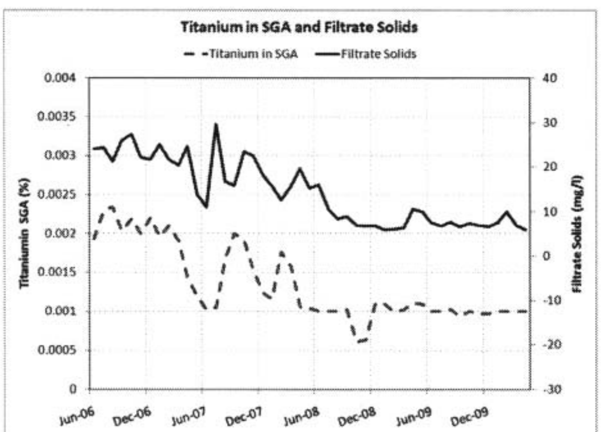

Figure 3: Titanium in SGA and Filtrate solids 2007 - 2009

During the 2007 plant expansion, the refinery replaced the sand filters with Diastar filters which are widely regarded as the most advanced fine filtration technology.

The change to Diastar filters resulted in the step reduction in iron oxide and titanium oxide in SGA. Refer to Figures 2 and 3.

<u>Process Improvements – Diastar Filters and Thickener Operations</u>

Following the commissioning, the refinery was faced with the challenge of adapting to the Diastar operations. Significant improvements were made in the following areas with the gains in calcia control being realized during 2008. See Figure 4.

<u>Operations Management:</u>

- Re-clothing practices
- Process Control to prevent Cloth Degradation
- Inventory Management of Filter parts
- Cloth Design

<u>Process Management:</u>

- Changes to dosing of flocculants to thickeners
- A visual management system
- Spigot sample to reduce time taken to identify defective filter elements.

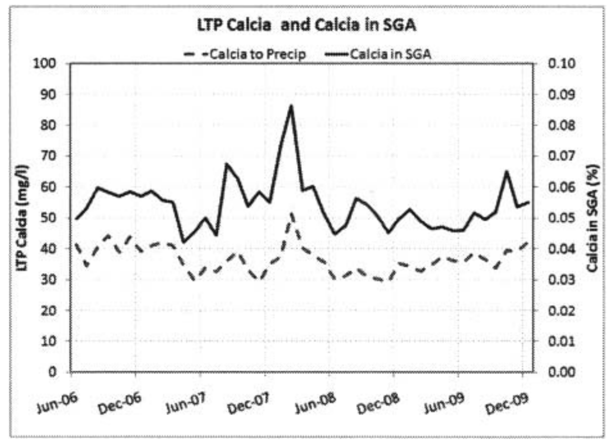

Figure 4: Calcia in SGA and LTP Calcia solids 2007 - 2009

Improvement in Na_2O and SiO_2

In 2006 CAW's precipitation department advanced its classification system by moving from gravity classifiers to hydro-cyclone classifiers. These changes required modification of the hydrate management and first precipitator control strategies so as to assure that the soda and silica levels in product meets the customer specification. Figures 5 and 6 illustrate the improvement in both the variation and absolute value of the Soda and Silica in product.

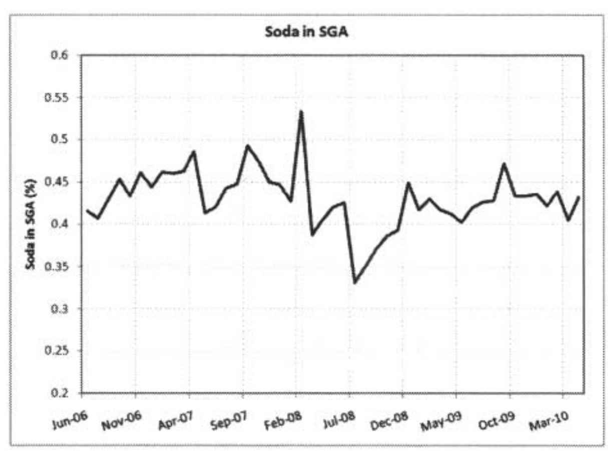

Figure 5: Soda in SGA 2006 - 2009

CAW experienced high variability in its first precipitator soda control immediately following the introduction of the hydro-cyclone classifiers in 2007. Changes in head tank control with the improved classification system positively influenced the fixed soda in SGA. These changes allowed the sustained reduction in the average value of soda in product from 0.45% in the second half of 2008 to 0.41% in 2009 and a reduction in variability from 0.09% in 2008 to 0.03% in 2009.

Silica in product is CAW's highest-weighted component capturing over 35 % of the CSI. Silica in SGA is affected by inter alia hydrate seed in contact with liquor for extended periods of time. Vessel failures in precipitation are one of the leading causes that present this condition.

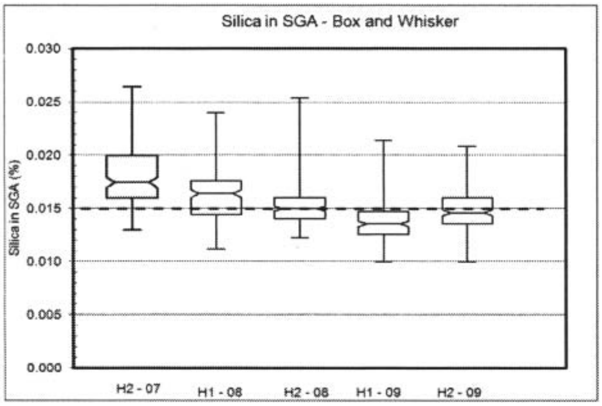

Figure 6: Silica - Box and Whisker plot

Introduction of a new hydrate management system and the revision to the procedure for returning a failed vessel to service has eliminated occurrences of silica excursions.

In 2007 silica averaged 0.17 ± 0.02 while in 2009 the silica averaged 0.14 ± 0.02

Conclusion

CAW has significantly reduced iron oxide, calcia, titanium oxide, soda and silica in SGA through:

- Switching from gravity sand filter to short cycle Diastar pressure filters
- Improved process management and control of the Diastar and precipitation operations

CAW has seen marked improvement in its product quality and continues to drive for improvement through the process of best practice transfer.

References

[1] Diastars filters, manufactured by Filters Gaudfrin (France), are cylindrical shaped pressure vessels with a cone shaped bottom and a domed shape removable top. They utilize a filter cloth as the filter medium, similar to a Kelly filter.