Impurities Control – From a Mine to a Plant

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Abstract

The Rusal Aughinish Alumina (AAL) refinery is located on Aughinish Island, on the southern shore of the Shannon Estuary 33 kilometres west of Limerick city in the South West of Ireland. The plant, which commenced operation in 1983, has a current production capability of 1 990 000 tons per annum. It sources bauxite predominantly from Guinea, Brazil and Guyana and uses the Bayer process to produce Alumina. The refinery functions with an accredited Safety Management System (ISRS), Environmental Management system (ISO14001), Quality Management System (ISO9001) and Energy Management system (ISO50001). The selection of plant design and technology for an alumina refinery is based on the physical and chemical composition of bauxite supply. For a chosen plant design and technology, production, costs and quality are optimised within boundaries specific to the refinery. However, changes to the chemical composition of the bauxite can require new technology to ensure critical impurities are controlled and avoid a loss in production capacity or a deterioration in product quality. This paper outlines the impact of a change in bauxite chemical composition on the control of impurities.

Keywords: Alumina refinery, bauxite, impurities.

1. Introduction

Aughinish was commissioned in 1983 at a design capacity of 800 000 tons per annum. The refinery design was based on high quality dry CBG bauxite (62%) and dry MRN (38%) bauxite: both bauxites had very high extractable alumina well above 50% with low level of organics in particular MRN with total organic carbon (TOC) three times lower than CBG. The refinery was designed by Alcan using the best technology available at the time: a Kaiser digestion, an Alcan precipitation and Alcoa calciners were installed. A single chain was built with enough available space to build another two chains: the refinery in 2017 is still operating on a single chain but the production capability has been increased to approximately 1 990 000 tons per annum. These design choices have introduced some operational mechanisms:

- The precipitation circuit is an oxalate-free circuit: the precipitation, classification, seed filtration and pumping systems can operate optimally only if the circuit is oxalate-free.
- The organics and impurities removal unit has a small removal capacity to manage low level of organics input. Bauxite with high organics input require a large removal unit commonly known as external causticisation.

The selection of plant design and technology for an alumina refinery is based on the physical and chemical composition of bauxite supply. Bauxite handling, method of extraction of the alumina content, mud circuit requirement and control of bauxite impurities are just a few critical aspects that have to be considered in the plant design. For a chosen plant design and technology, production, costs and quality are optimised within boundaries specific to the refinery.

The alumina content has an obvious impact on the capability and efficiency of a refinery: Figure 1 shows the alumina content reducing at Aughinish in recent years. As a result, additional bauxite is required to sustain production leading to higher level of impurities entering the refinery.

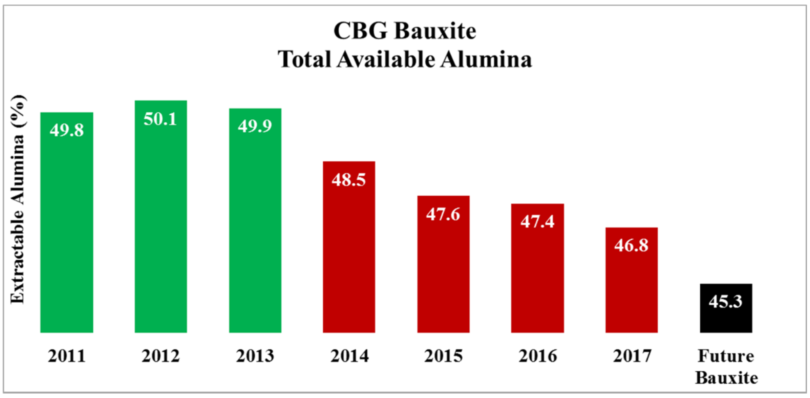

Figure 1. Reduction in extractable alumina in recent years.

The impact of bauxite on impurities in a refinery is often overlooked. The control of impurities is paramount to each alumina refinery and if not managed adequately the impurities would build up in the liquor as the liquor is recirculated continuously. Both inorganic and organic impurities can lead to serious plant problems if not controlled adequately such as:

- Deterioration in product quality due to product contamination, weak product and high level of fines in product caused by impurity interference with the crystallisation process.
- Reduction in process productivity; increase in costs caused by excessive fouling or scaling on key equipment such as heat exchangers, tanks and pipework.

Most of the impurities in the process liquor come from the bauxite and are modified through various chemical reactions occurring in the digestion process. Minor level of impurities are also coming from additives used in the process, oil and lubricants used for equipment, and return streams from the bauxite residue disposal area. Both inorganic and organic impurities require specific controls to ensure each impurity type remains in balance in the process liquor.

Mining operation has a significant role in providing both optimised chemical composition and low variability in the continuous bauxite supply as the capability of the refinery to control impurities cannot be adjusted. Changes to the chemical composition of bauxite can require new technology to ensure critical impurities are controlled and avoid a loss in production capacity or a deterioration in product quality.

The following sections will provide insight on the controls and limitations both at the mine and a refinery for the control of impurities. This paper focusses on a refinery designed for high purity blend of bauxites using Guinean bauxite as the main feed material. AlCircle website reported in March 2017 that Guinea is planning to increase bauxite production from 20 000 000 tons per annum in 2015 to 60 000 000 tons per annum by 2020 and move Guinea up the ranking in the top 3 producers of bauxite in the world with Australia and China [1].

2. Impurities Control – Starting at the mine

The production capability and operational stability at the refinery depends directly on a stable bauxite quality at an optimised quality level from the mine. In other words, the performance at the mine to deliver optimised bauxite quality parameters with little variability has a major impact on the performance at the refinery in terms of production, product quality and costs. The most critical operational aspects at the mine are:

5. Conclusions

The selection of plant design and technology for an alumina refinery is based on the physical and chemical composition of the bauxite supply: technology and equipment to control impurities play a critical part in the selection process. A bauxite quality change has to be thoroughly assessed and the bauxite quality must be compatible with the refinery technology.

The mine operation has a key role in controlling the overall bauxite quality and level of impurities, particularly its organics content. Optimised alumina, silica and TOC content with low variability in bauxite quality is critical to maintain production and performance in terms of product quality and costs.

A refinery such as Aughinish is highly optimised for its current bauxite blend and any increase in the level of impurities would require the appropriate technology modifications to overcome the change. This would necessitate a major programme of investment.

6. References

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