

Environmental and Economic Benefits of Bauxite Residue Management through the Use of Pressure Filtration, a Case Study

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Abstract



Filtration of Bayer process bauxite residue using filter presses permits efficient material handling and stacking. The low moisture content can also translate to improved soda recovery. The fine fraction of bauxite residue known as ‘red mud’ can be a relatively complex slurry, having a solid portion made up of a mixture of different phases which can influence the material’s filterability. For this reason, detailed testing of the residue slurry is necessary to define the filtration conditions best suited to achieve the required performance. This paper describes the different phases of testing that Bilfinger Water Technologies follows in determining the filtration conditions best suited to a particular slurry. A case study is presented in which Diemme® Filtration undertook characterization testing on a particular bauxite residue slurry. This allowed Bilfinger experts to define the kind of filter most suitable for this application, to achieve the required performance targets and to meet the plant operational and safety standards.

Keywords: bauxite residue, filtration; filter presses; bauxite residue slurry testing pilot; cake filterability.

1. Introduction

Bauxite residue is a by-product of alumina production. The residue is typically alkaline and requires safe storage to prevent environmental contamination [1]. This residue is treated with a Counter Current Decantation (CCD) system for soda recovery, which results in its volumetric and causticity reduction. Despite this process, the tailings obtained still contain residual alkalinity. The alkalinity in the residue is present as soluble caustic and alkalinity, and alkaline solids. The alkaline solids can dissolve in rainwater and continue to release alkalinity after the soluble caustic has been removed from the residue. Consequently, it is very important that the fine residue (red mud) is stored safely in secure impoundments that prevent groundwater contamination from caustic and also ensure the long-term mechanical stability of the deposit.

2. Bauxite Residue (Red Mud) Composition

Bauxite residue is a chemically complex matrix, whose composition is related both to the kind of bauxite consumed and to the process conditions. The working conditions of the CCD residue washing system are very important also, since they determine some fundamental characteristics of the tailings such as the solid concentration and residual alkalinity. As for its chemical composition, the main elemental constituents are Fe, Al, Si, Na, Ca, Ti, together with other metals that are present in smaller quantities. These constituents have wide ranges of concentration, as can be seen in Table 1 [2].

Table 1. Typical Elemental Composition of Red Mud.

Element	Content (% w/w)
Fe	25-55
Al	10-20
Si	5-30
Na	5-15
Ca	0-5
Ti	0-15

The reason for such wide ranges is bauxite's nature (gibbsitic, boehmitic or diasporic), which determines the mineralogical composition, which is always complex since it includes both phases already present in the initial bauxite and the ones produced during the process.

A common characteristic of all kinds of red mud is the very fine PSD, in most cases the D90 value is lower than 50 micron with the main population distribution peak lower than 20 micron.

3. Dry Stacking as a Means to Manage Red Mud

There are currently two kinds of residue storage methods [3]: wet storage and dry stacking. The first method is the most common one, it consists of pumping the Bayer process residue slurry coming out from the CCD system directly into a secure, sealed impoundment. This method has several disadvantages compared to the current dry stacking method, which involves thickening the residue slurry then drying in layers within secure, under-drained storage areas. As it consolidates and dries, more mud is laid on top to form a stable residue stack.

Further thickening or dewatering of the slurry to obtain a solid residue, which is then stacked in secure impoundments, avoids several problems such as:

- the risks caused by inadequate mechanical stability of wet storage (see Ajka disaster in 2010);
- the potential for groundwater contamination;
- higher capital costs because of the need for a larger areas of residue impoundments; and
- lower soda recovery.

The residue thickening and drying methods generally used are paste thickeners, drum filters, vacuum filters and filter presses and solar drying.

Filter press technology has advantages that make it particularly suitable for bauxite residue treatment. Compared to other technologies, filter presses allow drier residue (with residual moisture lower than 30% w/w). As a consequence, the material handling characteristics of the cake obtained by using filter presses are far better than results achieved by alternative methods. The resultant residue is intrinsically mechanically stable, minimizing the chance of mechanical instability in the resultant residue deposit. The reduced liquor content of the residue reduces the potential for groundwater contamination.

There are several equipment options available to produce suitably dry residue material such as recessed or membrane chambers, solid blowing or washing, etc. A particular option can be selected based on the characteristics of a particular residue slurry.

Diemme® Filtration is leader in designing and producing filter presses. Each filter press is carefully customized to account for the specific process requirements. The final result is obtained after an in-depth analysis in several steps, starting from the complete characterization of the mud to be treated, following by several testing steps carried out in pilot plants to determine the process parameters in the most accurate possible way. All this allows a filter press offering that satisfies the customer's process requirements in every respect.

4. Bauxite Residue Mud Characterization

The residue used in the test work reported in this paper comes from the CCD washing plant of Alcoa's Kwinana refinery (Western Australia). The product has been evaluated in several test campaigns between 2012 and 2014, and in each campaign, a complete chemical and physical characterization has been carried out. This allowed the collection of very important information about its variability.

The solid concentrations of the slurry are indicated in Table 2. The high degree of consistency in the values is guaranteed by the counter current washing thickeners.

6. Sizing and Characteristics of the Filter Press Provided

Once testing was completed, model selection and sizing commenced. Diemme® Filtration has a wide range of filter press models (side beam, overhead beam, pull to close, push to close) and sizes (from 500x500 mm plates up to 4000x3000 mm). For this specific case, the drivers in equipment selection were the heavy duty conditions of operation and the high tonnages to be treated. In general, for similar cases, the selected models are the GHT-P or GHT-F model.

During the interactive cooperation between Diemme® Filtration and Alcoa, it was discussed and agreed to proceed with the GHT-P model.

In view of providing a suitable model for several Alcoa refineries worldwide, the parties studied a solution with one filter press model to be adapted for at least 4 or 5 Alcoa refineries. The model is the GHT.2500.P18 with recessed 35 mm plates, having 2500x2500 mm plates. P18 means that the maximum plate pack length is 18 meters when full of plates (184).

The sizing of the filters depends on the calculation of a total filtration volume. In this calculation the parameters considered are daily tonnage of solids to be treated, achieved cake dryness, wet cake density, squeezing factor (if applicable) and number of daily cycles.

It is evident that, except for the daily tonnage (which is an input from the client), all the other information is a consequence of test results and vendor expertise. The number of plates is linked to the total filtration volume and for other Al refineries, Diemme® Filtration is still proposing the GHT.2500.P18 with a varying number of plates suitable for every specific case.

The achieved agreement is then a smart arrangement to deal with the several refineries with a kind of “modular approach” for both parties.

7. References

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