

# FACTORS AFFECTING TAA DETERMINATIONS FOR BAUXITE CHARACTERISATION

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## Abstract

Total available alumina (TAA) is usually determined by digestions of bauxite in caustic solutions. We have investigated two aspects of this digestion that can influence the result. For a gibbsite-boehmite mixture we have found that boehmite does not dissolve in pure caustic provided there is sufficient gibbsite dissolution to exceed boehmite solubility. This simplifies the TAA digests by removing the requirement for the digest liquor to contain pre-dissolved alumina. Additionally we have found that desilication product, formed in TAA digests using pure caustic contain higher levels of included alumina than would be expected in a Bayer liquor. The extra alumina causes an under-reporting of TAA. The under-reporting is a linear function of the reactive silica content of the bauxite and is  $\sim 0.125 \text{ g Al}_2\text{O}_3$  per 1% reactive silica in the bauxite.

## 1. Introduction

Traditional wet chemistry determinations of total available alumina (TAA) have consisted of digestions of bauxite in caustic solutions at nominated values of temperature, holding time and caustic strength. Extractable gibbsite and extractable boehmite can be differentiated by choosing the bauxite charge and digest temperature.

Two experimental factors have been examined which can influence the level of extracted alumina. The first factor is the possible dissolution of boehmite in the initial stages of a digestion of a bauxite containing both gibbsite and boehmite in pure caustic (Figure 1). The second factor examined was the incorporation of alumina into the cages of sodalite desilication product (DSP) that would otherwise report as part of TAA.

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## 2. Boehmite extraction in initial stages of a pure caustic digestion

Gibbsite extraction is normally measured at  $\sim 150^\circ\text{C}$ . No boehmite will dissolve at the end of this digestion provided the bauxite charge is sufficient to ensure a dissolved alumina level above boehmite solubility. However at the early stages of digestion where both gibbsite and boehmite are under-saturated, it is not clear whether both will start to dissolve at lower levels of alumina in liquor.

To counter this, digestions designed to target gibbsite only from a bauxite that contains both gibbsite and boehmite often contain pre-dissolved alumina at a level above boehmite solubility at the digestion temperature. This makes the determination more time consuming and less accurate (less bauxite can be used per volume of liquor). If digestions designed to dissolve gibbsite only could be done in pure caustic the test, would be quicker, cheaper and more accurate.

Mixtures of pure gibbsite and boehmite in various proportions were digested to  $150^\circ\text{C}$  in pure caustic using a gas-fired bomb at a heating rate of  $\sim 35^\circ\text{C}/\text{min}$ . In each case there was enough gibbsite to achieve alumina in solution above boehmite solubility. The residues were weighed, checked for LOI and analysed by XRD. For mixture ratios between 90:10 and 50:50 (G:B), the boehmite was found not to have dissolved at all, to within experimental error.

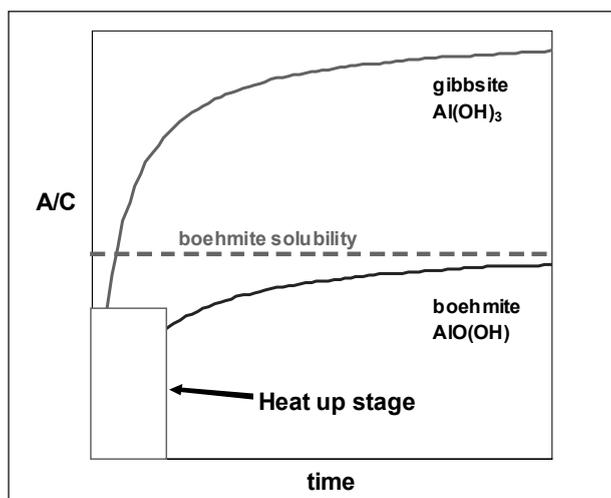


Figure 1. Schematic of dissolution profile for gibbsite and boehmite in caustic solution.

It is assumed that gibbsite (which dissolves faster than boehmite under equivalent conditions) rapidly dissolves, bringing the dissolved alumina to a level at which boehmite dissolution is small and/or negligible. It should be noted that sufficient gibbsite must be present in the bauxite or mixture to ensure exit dissolved alumina levels above boehmite saturation, and that this effect might depend on the accessibility of gibbsite / boehmite in a real bauxite and the temperature heating rate in digestion.

## 3. Disproportionate aluminate inclusions into DSP during TAA digests

When sodalite DSP forms during a digest in Bayer liquor, it includes in its structure a variety of anions, the distribution of which depends on the concentration of those anions in the liquor (Figure 2).

In a TAA digest, there are generally no impurities, and the only anions present are aluminate and hydroxide. The extra aluminate in a sodalite from pure caustic compared to a sodalite from Bayer liquor represents an aluminate loss to reported TAA.

Our experiments show that under a range of conditions (especially exit A/C) sodalite formed in pure caustic has an aluminate "occupancy" from 61% to 65% (i.e. 0.61 to 0.65 mole of included  $\text{Al}_2\text{O}_3$  per 6 moles of reactive silica). This compares to  $\sim 15\%$

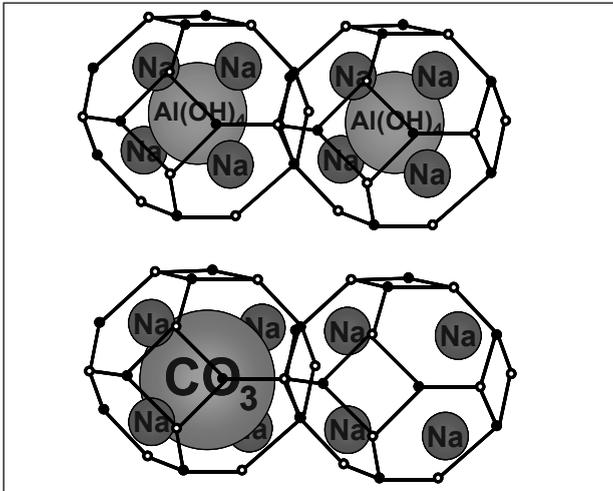


Figure 2. Schematic of sodalite unit cell (two cages) with full aluminate (upper) or carbonate occupancy (lower).

in Bayer liquors with substantial impurity (SO<sub>4</sub>, CO<sub>3</sub>, Cl) levels. This latter figure is an average value from a variety of liquors representative of Australian processing conditions determined previously in our laboratory (Riley *et al.*, 1999).

The shortfall is linear with reactive silica content of the bauxite and corresponds to ~0.125 g Al<sub>2</sub>O<sub>3</sub> per 100 g of bauxite with a 1% reactive silica. This translates to an under-estimate of ~0.5% for a TAA with 4% reactive silica, or a significant ~1% for a high (8%) reactive silica bauxite.

## References

Riley G., Smith P., Binet D., and Penniford R., (1999) Proceedings of the Alumina Quality Workshop (AQW 5, Bunbury), pp404-414.