

BR04 - Comparison of Lime and Carbon Dioxide Methods of Bauxite Residue Neutralization

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Abstract



To promote bulk amount of bauxite residue (BR) utilization as industrial raw material, cost-effective and efficient reducing total alkali content ($\Sigma R_2O = Na_2O + K_2O$) below 1 mass % shall be achieved.

Following on from the RemovAl project the efficiency of carbon dioxide neutralization of BR was studied. Chemistry of the process was examined, and expert evaluation was performed to assess the availability of implementation of the carbon dioxide method under the process conditions of an alumina refinery. Some limitations were determined. Competitive abilities of carbon dioxide and lime BR neutralization methods were evaluated.

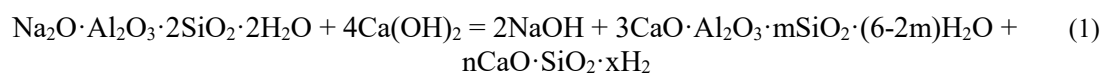
Keywords: Bauxite residue, lime neutralization, carbon dioxide treatment, carbon footprint.

1. State of the Problem

Bauxite residue (BR) can be used as industrial raw material only if a cost-effective and efficient technology is available for reducing the alkali content ($\Sigma R_2O = Na_2O + K_2O < 0.5$ mass %) and the moisture content ($W \approx 25\div 30$ mass %) in BR. A traditional method of BR neutralization comprises processing BR with lime to recover the alkali and return it to the Bayer process. However recently a number of alternative methods have been studied on both laboratory and industrial scale which combined BR preparation for secondary use and reducing the carbon footprint from alumina production. These methods are discussed below.

1.1 Lime Neutralization

In the 1930s, a method of BR neutralization with lime was proposed that enabled to decompose desilication product (DSP) with alkali dissolution in form of NaOH [1]. The process is based on the reaction of DSP decomposition with lime:



Following lime regeneration BR is filtered on a filter press to separate the cake with a moisture content of ≤ 30 %; and the resulting caustic alkali solution is returned to the mud circuit of the alumina refinery [2]. A significant part of the lime regeneration costs is compensated due to the following:

- the return of caustic alkali to alumina production to compensate for losses;
- the sale of neutralized and dehydrated BR to customers;

- or reduction of environmental payments for disposing waste of a lower hazard class using ultra-dry storage technology, which increases the usable capacity of the bauxite residue disposal area.

However if neutralized and dehydrated bauxite residue cannot be used as industrial raw material, the extensive use of lime neutralization technology at alumina refineries is doubtful, since use of lime increases the carbon footprint of alumina production, which is on average equal to approx. 1.2 t CO₂ t/t Al₂O₃.

1.2 Acid Neutralization

Acid neutralization involves treating BR with sulphuric (in rare cases hydrochloric) acid with DSP decomposition and Na₂O dissolution in form of sodium sulphate Na₂SO₄. Spent sulphuric acid solution from chemical cleaning of the heating surfaces of heat exchangers and/or evaporators to remove scale formation is often used for this purpose. Acid reduces pH level of BR liquid phase from ≥ 13 to ≤ 8 and facilitates the dissolution of up to 85 % Na₂O in form of Na₂SO₄ [3]. In order to reduce acid consumption and to resolve the issue of disposal of the resulting sulphate solution CSIRO proposed to treat the sulphuric acid solution from BR neutralization using electro dialysis process. This method enables to return Na₂O to the Bayer mud circuit while feeding sulphuric acid to the beginning of the process to neutralize the fresh batch of bauxite residue [4]. This closed process of acid neutralization followed by electro dialysis has not been pilot tested, so no feasibility data of the process or actual implementation experience are available.

1.3 Cold CO₂ Treatment with Complexion

Complexion is a complex nitrogen containing organic substance making strong bonds with most cations [5]. Complexion treatment of DSP in the presence of CO₂ (required for pH regulation) results in DSP decomposition and dissolving salt of a complexione with aluminum (AlY), solution of sodium hydrocarbonate (NaHCO₃) and silica gel Si(OH)₄ as follows:

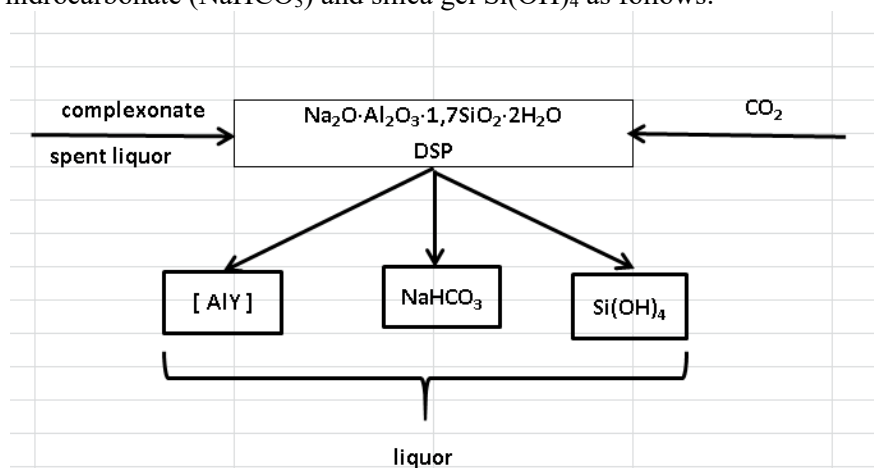


Figure 1. Cold CO₂ treatment with complexion for DSP decomposition.

Further processing successive steps include: separation (filtration) of silica gel; separating (filtration) dawsonite, i.e. sodium and aluminium hydrocarbonate NaAlCO₃(OH)₂. When heated to ≥ 600 °C dawsonite decomposes in two stages to sodium aluminate NaAlO₂ with a loss of crystalline hydrate moisture and CO₂ groups:



8. References

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