Bauxite Residue Disposal Area Rehabilitation

Kevin McMahon
Bauxite Residue Disposal Area Coordinator
Aughinish Alumina Ltd., Askeaton, Co. Limerick, Ireland
Corresponding author: kevin.mcmahon@augh.com

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, is currently producing 1.965Mt/yr. 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 bauxite residues generated from the Bayer process are deposited in an engineered facility called the Bauxite Residue Disposal Area (BRDA). The operation of the BRDA is one of the key enablers to execute the BRDA closure plan. Partial neutralisation of the mud by atmospheric carbonation through mud farming produces a mud with pH<11.5 which is suitable for remediation and revegetation. The preferred land-use option post closure, based on current knowledge of the chemistry and biology of the sown grassland cover, is to develop the area for nature conservation. This paper outlines the field studies, which have demonstrated that bauxite residue can be successfully rehabilitated.

Keywords: Alumina refinery, BRDA, bauxite residue, rehabilitation.

1. Introduction

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 1.965Mt/yr. It sources bauxite predominantly from Guinea, Brazil and Guyana and uses the Bayer process to produce Alumina.

Green alumina has a key role to play in creating green aluminium. The production of green alumina at AAL is key to the environmental sustainability of the refinery. This sustainability is multi-faceted and includes bauxite residue disposal management, continuous monitoring to ensure there is no impact on the local environment and minimisation of CO_2 emissions [3].

This paper outlines the approaches taken by Aughinish to achieve revegetation and support ecosystem development on bauxite residue. The refinery at Askeaton, Co. Limerick currently produces approximately 1.37 Mt of bauxite residue per annum, which is stored in a Bauxite Residue Disposal area (BRDA) of 183 ha.

Rehabilitation involves amendment with a carbonation process to neutralise the pH, following this, gypsum and residue sand is effective in improving physico-chemical properties and promoting seedling establishment and growth. Application of compost is used to overcome the nutrient deficiencies of the residue [1]. Years of research in conjunction with the University of Limerick have established with this combined approach, several grassland species have successfully grown on the residue enabling the primary restoration goal to be achieved [1]

Conditions issued by the Environmental Protection Agency (EPA) outlined in the Industrial Emissions License (IE) stipulate that a closure scenario be enacted on a dedicated section of the BRDA to demonstrate that developed methodologies are adequate to successfully achieve closure. For the past 20 years AAL have a successful monitoring programme in place to demonstrate the success of the vegetation cover system. The establishment of a sustaining vegetation cover is the preferred method for post-closure management of the residue storage area to rehabilitate the residue, improve its aesthetic impact and develop an area for nature conservation

Since 1996 in conjunction with the University of Limerick, AAL have conducted a series of revegetation trials on the residue both at laboratory and field level to develop a revegetation programme and a revegetation recipe for the management of residue in the BRDA.

2. Residue Processing at AAL

The residue is dewatered by vacuum filtration to a solids concentration of 58 % before being slightly diluted and transported, by a 2km pipeline, to the BRDA where it is discharged, spread and allowed to consolidate and dry in layers. Two-metre high rockfill embankments form a stable boundary to stack the layers and increase the BRDA in height.

2.1. Atmospheric Carbonation

There are several stages to post deposition treatment. As mentioned after vacuum filtration, the residue is diluted with water, sheared, thinned in an agitated tank and then pumped as a 58 % solids paste to the BRDA. In this state, the deposited residue cannot yet be traversed by conventional machinery and first must be dewatered and compacted. An amphibious vehicle called an Amphirol is employed to carry out this de-watering and compaction process known as farming.

The Amphirol travels using scrolls, to allow the vehicle to move through the residue. As the Amphirol travels, it compresses the residue and creates tracks or furrows. These furrows allow the water, which has been “squeezed” from the residue to drain along the sloping stack towards the perimeter wall of the cell and into the perimeter channel.

Once the residue has compacted to > 70 % solids by multiple passes of the amphirol, the surface is then graded by a bulldozer to level the surface and generate a constant gradient from the discharge (high point) to the perimeter wall (low point). This makes the residue suitable for conventional agricultural machinery to travel and operate on its surface. Atmospheric carbonation of the residue by the amphirol and agricultural machinery allows for exposure of the residue to CO_2 in the air. Sufficient exposure and carbonation reduces the causticity below 30% and reduces the residue pH below 11.5. This is the mechanism by which the residue is exposed to atmospheric CO_2. Once carbonation is completed as evidenced by pH measurements of samples from the cell, the area is then re-graded using a bulldozer to remove any depressions. The cell is then ready for the subsequent layer of bauxite residue.

3. Legislation

Although earlier planning permissions granted to the refinery contain requirements with respect to landscaping and restoration of the BRDA, the Integrated Pollution Prevention Control Licence (IPPCL) introduced in 2008 issued by the EPA contained many stringent conditions for BRDA restoration and aftercare. Since its issue in 2008, the licence has been updated in 2012 and most recently in 2014 to the Industrial Emissions License (IE P0035-06). Over the years,

and indicates that colonisation by further species occurs on areas once vegetation is established [1].

The extracted DNA concentrations from treated bauxite residue are within the range of extracted DNA concentrations from natural soils, treated bauxite residue has been shown to contain diverse soil-like bacterial communities [3].

At a portion of the financial cost of a traditional cap and cover remediation, these treatments provide a cost effective and viable solution to BDRA closure and residue rehabilitation.

In conclusion, research has shown that vegetation can be successfully grown on bauxite residue, giving a sustainable vegetation cover come closure. AAL have been and continue to be proactive in researching suitable capping methods and demonstrating its success. Strict licensing conditions coupled with ongoing research will ensure an environmentally viable capping method at Aughinish. The overall environmental footprint at AAL ensures that there is no impact on the environment and the community.

9. References

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