

Operation of Utkal Refinery – Best Practices and Utilization of Bauxite Residue at Hindalco

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Abstract

Bauxite residue (BR), a highly alkaline by-product of the Bayer process for alumina production, poses challenges related to handling, storage, and environmental management. Addressing these issues is essential for advancing sustainable practices within the aluminium industry. Hindalco has adopted scientific approaches to convert this industrial waste into a secondary resource aligned with sustainability and circular economic principles.

This paper presents Hindalco's advanced Research and Development (R&D) initiatives focused on the large-scale and viable utilization of BR through material innovation and industrial symbiosis. Additionally, it highlights the advanced debottlenecking methodologies and Industry 4.0 technologies implemented at Hindalco's Utkal Alumina Refinery to enhance operational sustainability, improve resource efficiency, and support long-term circular economy objectives.

A key established pathway for BR utilization is its application in cement manufacturing, supported through partnerships with the cement industry. Compared to laterite or bauxite, BR offers higher reactivity, finer particle size, and inherent alkali content, which contribute to enhanced cement kiln performance, reduced raw material and grinding costs, and improved overall production efficiency. Additionally, its alkaline nature, together with the presence of iron oxide and alumina, helps compensate for deficiencies in conventional raw materials such as limestone while improving sustainability through the beneficial utilization of industrial waste.

Another key R&D focus of is the application of BR in road construction. A pilot study with NHAI (National Highway Authority of India), CSIR – CRRI (Council of Scientific and Industrial Research-Central Road Research Institute), and IMMT (Institute of Minerals and Materials Technology) evaluated technical and economic feasibility which led to construction of a pilot road near Koraput, Odisha. Additional initiatives include developing standard operating procedure (SOP) for the country for abandoned stone quarries backfilling and eco-restoration in collaboration with DFO (District forest official), AAI (Aluminium Association of India) and IIFM (Indian Institute of Forest Management). With IIT (Indian Institute of Technology) Bombay, BR polymer composites are prepared to produce paver blocks, tiles, and bricks. Aggregate development with University of Greenwich has also been successfully demonstrated. Furthermore, Hindalco is exploring iron recovery with various technology partners, enabling its potential use in pig iron, steel, and cast-iron production.

Keywords: Bauxite residue, R&D, Cement manufacturing, Road construction, Industry 4.0.