An Overview of Bauxite Residue Utilisation

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Abstract

Bauxite residue is a solid waste generated during the production of alumina from bauxite. The disposal of this waste is a global challenge due to its potential environmental impact. If not well managed, its high alkalinity is a potential source of contamination of water, land and air in close proximity of the disposal site. Extensive work is carried out by researchers worldwide on value addition and fruitful utilization of bauxite residue. Some of the opportunities for utilization include adsorbents for the removal of heavy metals, dyes, phosphate, nitrate and fluoride; preparation of catalysts; recovery of iron, titanium and other trace metals; production of radio opaque materials; production of construction bricks; wood substitutes; cement; geo-polymers; development of coatings and pigments. This paper examines the details of bauxite residue utilization with the ultimate aim of solving the challenges of disposal and environmental impact.

Keywords: Bauxite residue utilization; wood substitutes; coatings and pigments; radio opaque material; geo-polymers

1. Introduction

Aluminium is a light weight, high strength structural material. Bauxite is the most economically important aluminium ore due to the presence of its high alumina content. Bauxite is a lateritic rock and contains mainly gibbsite, boehmite and diaspore. Bauxite also includes the iron oxides, goethite, hematite and small amounts of titanium, silica and other minerals and other impurities in minor or trace amounts. Bauxite usually contains the clay mineral kaolinite and has a density ranging from 2 600 to 3 500 kg/m³. Bauxite colour varies from whitish to pink to reddish brown depending on the iron content in the bauxite[1]. Globally, estimated bauxite resources are 55 to 75 billion tonnes, located in Africa (33 %), Oceania (24 %), South America and Caribbean (22 %), Asia (15 %) and elsewhere (6 %). India is self-sufficient in bauxite and has 3 billion tonnes of bauxite reserves out of global reserve of 65 billion tonnes. This places the country 5th in rank in the world [2]. Bauxite is classified based on ore type. These are mineralogically different and their occurrence in different countries is given in Table 1.

<table>
<thead>
<tr>
<th>Gibbsitic</th>
<th>Boehmitic</th>
<th>Diasporic</th>
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<tbody>
<tr>
<td>Australia, Brazil, Guyana, India(Eastern Coast), Indonesia, Jamaica, Malaysia, Sierra Leone, Suriname, Venezuela.</td>
<td>Australia, Guinea, Hungary, USSR, Yosglavia, India (Central part.)</td>
<td>China, Greece, Guinea, Romania, Turkey</td>
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Aluminium production involves three stages: bauxite mining, followed by the refining of bauxite to alumina, usually in the Bayer process and smelting of alumina to aluminium by the Hall-Heroult process. Alumina can also be produced from bauxite under alkaline conditions using the lime sinter process [4], Deville Pechiney process(sodium carbonate) [5] and using the Serpeck process at high temperature in a reducing environment in presence of coke and nitrogen [6]. The Bayer process[7] is the most economic and prevalent method employed for extraction of alumina from bauxite, where it contains sufficient Al₂O₃ content. Bauxite of higher silica content is not suitable for the Bayer process and is more economically processed by the