

BAUXITE RESIDUE VALORISATION AND BEST PRACTICES CONFERENCE

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Bauxite Residue and other Waste Materials in Light Weight Aggregate Production using a Trefoil Kiln

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Problem

- Wastes such as sewage sludge and fly ash from power stations, cost money to dispose of *.
- There is an added danger that heavy metals can leach into the environment.

* Some fly ash could be used as an additive to cement but some compositions of fly ash cannot be used and cause a problem

Solution

- The trefoil process: converts waste into energy and light weight aggregate (Lwa)
- Waste materials are combined and fired to produce a light weight aggregate.
- During the process, the heavy metals are locked inside the aggregate and do not leach.
- Paid to recieve the wastes, and product is sold.

Tilbury, UK

(Mark I full scale plant, built around 2001, due diligence by star capital)

Plant capacity 240,000m³ aggregate pa



Chongqing Demo Plant, China

Demo plant for the Mark II design: using this demo plant it was proven that the local waste could be used for the process



Materials Used

Bulking materials

- Any material which can be handled, dried to powder and will sinter below 1200°C including:
 - Pfa
 - Clay
 - Other ashes from MSW, CHP, sewage incineration etc.
 - Shales
 - Aggregate crushing / washing fines
 - Glass fines (also acts as flux)

Fuel Materials

- Any biodegradable material which can be handled and can either be dry powdered or will slurry including:
 - Sewage cake
 - Biodegradable part of MSW
 - Carbon / slag from gasification
 - Paper pulp cake
 - Farming slurries and Chicken/turkey wastes

For all materials a balance has to be determined between waste revenue, effect on product and resulting product revenue, cost to incorporate into process and effects on emissions

Inclusion of Red Mud in the Process

- Using a predetermined ratio of PFA:sewage sludge:clay as the starting point. PFA was replaced by red mud on a dry weight basis.
- Mixes were made from 20-70% red mud and these were pelletised and put through the process.
- The aggregate produced was evaluated in terms of strength, water absorption, loose bulk density.

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Abstract

Waste materials that may be problematic to dispose of, for example, pulverised fuel ash (PFA), ash from other fossil fuel sources, sewage sludge and river silt can be palletised and fired to produce manufactured aggregate that can be used to replace the use of natural resources. In this paper we report on the inclusion of bauxite residue from China into a lightweight aggregate containing PFA, sewage sludge and clay. Aggregate was made with a content up to 70% bauxite residue. The aggregate produced was still within the loose bulk density specifications to be considered lightweight up to and including 60% dry weight bauxite residue. This data was a small scale study demonstrating the feasibility of incorporating large amounts of bauxite residue into lightweight aggregate.

Introduction

In China, there are no official disposal methods for this waste, so it is usually 'reused' on site at the alumina factory. It is estimated that more than 70 million tons of red mud are produced annually in China (1) and over 100 million tons per year globally (2). Obviously a long term, financially and environmentally viable option needs to be found for this waste.

Waste materials can be palletised and fired to produce manufactured aggregate that can be used to replace the use of natural resources. Two types of waste are used in the process: bauxite residue and fuel material. Bauxite residue, a G, pulverised fuel ash (PFA) make up the structure of the aggregate, while the fuel material is any biodegradable material that can be dried or mill slurry such as sewage sludge (3).

The data presented here describe the inclusion of bauxite residue from the CO region of China into our process of aggregate production and the effect this has on the strength, water absorption and bulk density of the aggregate.

Methods and Materials

The production and firing of the aggregate was carried out at the University of Chongqing, China, using equipment supplied by RTAL (HK) Ltd, including a Trefoil kiln supplied by Trefoil Technology (4).

The ratios of PFA, sewage sludge and clay that give a strong light weight aggregate have been previously determined.

PFA was replaced by bauxite residue on a 1:1 dry weight ratio. The replacement percentages were 25, 51, 56, 64 and 70%.

The pallets were fired in 3-4kg batches up to a temperature of approx. 1200°C. A 1/8" crusher seal was used (5) to determine the strength of the aggregate.

The particle density and water absorption of the aggregate were characterised according to BS EN 12620-2:2002.

Results and Discussion

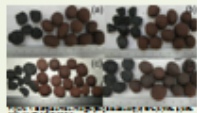


Figure 1: Fired aggregate pallets (a) and (b)

Given up to 70% red mud content replacing PFA, the mixture was still palletisable and the pallets held together and could be fired in the kiln.

Examples of the fired aggregate produced is shown in Figure 1 and its internal structure can be seen on the left hand side of each picture.

Lightweight aggregate is worth more than standard aggregate so it would be desirable for the aggregate to be lightweight.

As the amount of red mud increased above 60% in the pallets the strength of the aggregate decreased (Figure 2).

The water absorption of the aggregate decreased as the content of red mud increased (Figure 3).

The loose bulk density increased significantly when the total content of red mud was 60% (Figure 4). At this level it is still classed as lightweight aggregate but is 70% in mass so dense.

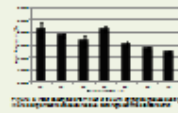


Figure 2: Strength (MPa) vs. Bauxite Residue Content (%)

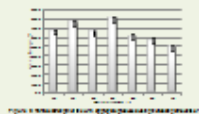


Figure 3: Water Absorption (%) vs. Bauxite Residue Content (%)

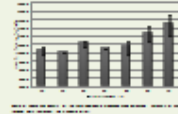


Figure 4: Loose Bulk Density (kg/m³) vs. Bauxite Residue Content (%)

Conclusions

- The chemical composition of bauxite residue varies widely. These tests demonstrate that the type found in the CO region of China at least is suitable for lightweight aggregate production.
- Bauxite residue can be used to produce lightweight aggregate in a mix with clay, sewage sludge and PFA.
- Above 60% bauxite residue content the aggregate produced was too heavy to be classed as lightweight aggregate and also had decreased strength.
- The leachates of the aggregate have also been studied (6) and the leach were found to be below the levels set by European landfill directives (2009/18/EC).

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Come and read the results at coffee time.