Potential Commercial Processes for the Utilization of Bauxite Residues

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Abstract

The single most serious waste challenge in the production of aluminum is the generation of bauxite residues (red mud) in the alumina refinery process. Unique solutions for small amounts of material arise and research is being done on many higher technology solutions. This paper will cover a potential relatively simple technology solution for the conversion of large amounts of the waste product for the manufacture of brick building products on an industrial scale. Utilization of the J.C. Steele, stiff extrusion process and the combination of standard brick manufacturing technology can produce single manufacturing plant sites to convert up to 500,000 tons per year of bauxite residues. This paper will describe this potential and review the steps to evaluate if a particular alumina refinery's residues are a candidate for this process.

Keywords: Bauxite Residue, red mud, brick, stiff extrusion, J.C. Steele.

1. Background

There has been a tremendous amount of work done in the area of recycling and reuse of this difficult material. This author has spent his career in the area of aluminum dross and more recently SPL recycling. Bauxite residues are a new area of focus, I however have found, when looking at the development of a recycling process, examining and applying simple industrial solutions to waste issues that may have been over looked before can be surprisingly beneficial. Non-related industries can provide surprising solutions. I want to stress that I am new to this material and it's recycling solutions. I have read many good papers on the current status of this technology and hope this paper generates discussions on why the "stiff" extrusion technology may or may not be a good solution for some portion of this waste material.

In almost every paper that I have researched on bauxite residues, construction materials is always one of the simple solutions mentioned. Yet, the actual estimated use in this industry is very small compared to the total generation of this waste. 100,000 – 300,000 tons was an estimate given in 2015 [1]. This use amounts to less than .25% of the annual amount of red mud generated. My assumption is that there are two primary reasons for this. First these materials can be very different from site to site. Where a solution may be good at one site it is not at another. Second, solutions seem to be somewhat site sensitive depending on commercial aspects of potential products. The current cost of disposal of this material is estimated to be $4-12/ton [2]. This is very low and part of the difficulty in getting a viable commercial solution for this waste generation challenge. The economics of producing a high volume, real product of commercial value and positive social impact to developing countries however is worth the effort and evaluation.

2. JC Steele – Stiff Extrusion Process

The J. C. Steele and Sons company was founded in 1889 in Statesville, NC USA and has served the brick industry from the time of it's formation. Steele had the benefit of many local customers to work with in developing machinery, parts, and ideas for the brick making process. Over time, this reach expanded to current day with 11 locations and close to 400 employees

worldwide. The company is internationally recognized for it's expertise in the stiff extrusion process, or extruding a product durable enough to be handled immediately following extrusion. Steele's stiff extrusion technology allows brick makers the ability to extrude a "stiffer" column. This column stiffness allows manufacturers to extrude a product durable enough to be handled immediately following extrusion. In most cases, brick manufacturers using Steele extruders set products directly on kiln cars for both drying and firing. This is the most efficient, commercial manufacturing process for brick making. Steele extruders deliver the reliability for high volume production with a simple process.

Steele specializes in scalable process solutions, with single-line systems producing 10-100 TPH. The equipment provides a combined turnkey product, plant and application engineering to ensure a reliable stream of high-quality feedstock.

Since 1998 it has expanded to processing various waste products for reuse applications. Such as pelletizing nickel, iron and steel waste for direct reduction back to nickel, pig iron or steel.

3. The Material Evaluation Process

Appraising if a particular red mud source is suitable for producing bricks or iron pellets is the next step in the broader evaluation of the feasibility of this process for the industry. We are actively soliciting representative samples of material from sites that would find the economics and social benefits of this idea a real potential. Below is a description of such a test with the positive results. Smaller representative samples are typically first qualitatively analyzed before more extensive testing to judge the materials extrudability.

The international customer came to J.C.Steele for testing in 2012 to evaluate the potential of making bricks from their bauxite residue. Two samples of raw materials were supplied for evaluation; one clay and the other "red mud". The purpose of the test was to evaluate the potential of using the red mud as a component in the extrusion of fired ceramic brick and block.

The clay, local to customers site was supplied as-mined and had not been ground. Therefore, it was first ground and screened to 10 mesh (2.0mm). The red mud was delivered wet and actually had the consistency of thick mud.

To evaluate the use of this red mud in an extrusion body, various mixes were prepared and extruded on a 76-mm diameter auger lab extruder. The mixes ranged from 25% to 90% red mud. All were extruded using a 28.6mm square die. To evaluate the suitability of the material for thin-walled extrusions, successful mixes were also extruded through the same square die with a large center core to produce thin extruded cross-sections.

Following the test, all samples and remaining materials were sent to Clemson University for further evaluation. The results were that this material was a good candidate for stiff or semi-stiff extrusion. Extrusion and drying were acceptable at red mud content up to 75%. Extrusions with more than 75% red mud were not successful. Final determination of brick quality after kiln drying had not been done in this testing program.

4. Experimental – Description of Test Setup

A Hobart laboratory mixer was used to simulate the mixing with water and pugging of the ground feed material in the open tub of the pug sealer. The laboratory extruder simulates the processing of the material through the sealing auger and die, into the vacuum chamber, and then final extrusion. The laboratory extruder consists of two chambers with a sealing die between. The rear chamber is fitted with a 3-inch diameter sealing auger that pushes material through the

7. Step Two – Manufacturing Facility Evaluation

J.C. Steele & Sons is a provider of grinding, mixing, and extrusion equipment, the drying and firing data is for initial evaluation information only. Their partner firm Direxa Engineering is a brick manufacturing facilities design and supply firm and would use this data as a basic of design information for accessing the potential of the entire brick making facility. It would be Direxa's responsibility to evaluate with the customer the other equipment supply, such as the dryer and kiln, cutting and handling equipment, and the die design to determine material properties that will affect the design of their supplied equipment.

8. Summary

The alumina production industry would be well served if an economical method could be developed to convert the bauxite residues in commercial products. The stiff extrusion process as manufactured by J.C. Steele has successfully tested materials and turned them into useful brick shapes. Further testing, product evaluation and economic evaluations need to be completed on a site by site basis to see if this process can help reduce the amount of this waste going to land fill storage. GPS Global Solutions is actively pursuing test sites for evaluation process.

9. References

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