Retrofit opportunities in aluminum smelter using DIDION rotary thimble cleaning and carbon crushing equipment

David J Roth
President, GPS Global Solutions, Downingtown PA., USA
Corresponding author: david.roth@global-solutions.us.com

Abstract

All primary aluminum smelters are interested in improving their efficiency and energy saving. Two areas where DIDION rotary processing equipment can improve the efficiency of operation, energy use and significantly reduce existing maintenance cost is in the crushing of spent anodes and cleaning cast iron thimbles and pig iron. Aluminum smelters typically use a series of crushers, conveyors screens and magnetic separation for crushing spent anodes for recycling into the green carbon plant. Maintenance costs on this type of equipment in ageing smelters are quite high and the downtime significant. A DIDION RT Crusher can replace an entire crushing line, encompassing several primary, secondary and tertiary crushers with one unit capable of receiving full size baked scrap carbon blocks and spent anodes at production rates up to 30 tonnes per hour. The thimble cleaning operation in most smelters is typically done with a series of storage hoppers and conveyors into a batch processing shot blast unit that uses steel shot as a consumable product. After processing, the thimbles are often still carbon contaminated, which reduces the quality of the iron collars for cast iron sealing of carbon blocks to the anode rods and thus increases the stub-to-carbon voltage drop in the cells. With age these systems become expensive to maintain. The DIDION thimble cleaner simplifies this process, requires less production space and produces a cleaner thimble as well as pig iron for cathode assembling.

Keywords: Processing of spent anodes; DIDION crusher; DIDION thimble cleaner.

1. Introduction

DIDION has the most widely developed equipment and applications for rotary crushing and separation systems for the recycling and recovery of dissimilar materials that are often mechanically bonded together. The development of this technology was started in the foundry industry in the early 1970's. The first step was the separating of metal castings from the foundry sand mold pieces in which the castings were created. Handling these hot, heavy castings required the development of a very durable machine. The equipment was next used for sand reclamation applications to keep these foundry materials in use and out of landfills.

The continued improvement of the DIDION RT/RS TUMBLERS has made mechanical processing of mixed materials a very cost effective and low maintenance alternative to other processing systems [1]. These flexible systems can perform surface scrubbing, crushing, screening and sizing in one single piece of equipment. The DIDION systems take up far less space than conventional crushing and screening process facilities. While at the same time the system requires less maintenance and manpower to operate.

2. Basic system design features

There are four basic features of the DIDION RT/RS Rotary Processing Systems:

- First, the ability to process very large pieces of feed stock in the same processing step as finer materials. Depending on the model, up to 1800 mm (72") blocks can be processed at the same time as granulated fines.
- Second, the ability to "scrub" a surface removing materials that are foreign to the base structure allowing for valuable base structure materials to be recycled and reused.
- Third, the ability to crush with controlled fines generation and full dust control.
- Fourth, the ability to classify several sizes of material from bag house dust to 1800 mm (72") solid metallic pieces, within the same piece of equipment.

Figure 1. DIDION RT 108 DIDION Crusher / Metal Separator.

3. Spent carbon anode processing

The standard recycling process for spent anodes typically involves a primary jaw crusher, two or three horizontal shaft impactors and several cone crushers for the final carbon sizing. Magnetic separation units for the removal of tramp iron in the crushed carbon are located at multiple locations in the processing line. Multiple conveyors and screens keep the material flowing in the right size to the right crusher. If there are full size, either green or baked anode blocks that are scrap, they have to be handled separately and manually crushed. Thimbles and stubs must be removed from the process line as they could seriously damage the jaw and impact crushers.

Conversely, the RT systems will handle full size baked carbon anodes and crush them without any problems. Stubs/spiders can be charged into the unit without any fear of damage, as they will be restrained to the first crushing chamber and simply help in the autogenous crushing process.

The purpose of cleaning the thimbles is to have more efficiently operated pots in the potline. The pay back of the system outside of the operating cost and maintenance is due to a reduction in anode voltage drop.

The average anode voltage drop between the stubs on the anode rods and the carbon anode is approximately 120 mV. MetalTech of Iceland, with some smelters has made *in situ* tests by comparing the mV drops in stubs not cleaned with proper stub cleaning technology. The result was that stubs properly cleaned showed in average 10 % reduction in this anode voltage drop or some 12 mV based on actual performance measurements at these smelters. MetalTech estimates that proper thimble cleaning with removal of carbon and electrolyte material from the cast iron before remelting in the induction furnaces will also reduce the anode voltage drop some 5 % or 6 mV.

It is estimated that proper thimble cleaning by the Rotary Carbon Separator will readily achieve an improvement of 6 mV, meaning power savings of 5 % of the anode voltage drop between the stubs on the anode rods and the carbon anode. This is a significant energy savings and helps with a rapid project payback period of only 1 – 2 years.

8. General comments

The installation space requirement for the largest RT unit in a carbon crushing application is an envelope of approximately 6 x 30 meters (20 x 100'). The envelope for a typical RS for thimble cleaning application is 5 x 10 meters (15 x 30'). This layout would assume that materials discharge into tubs. Conveyors can be added to the system for continuous input and removal of the products. These conveyors can be set up in many configurations for additional separation steps such as magnetic separation and/or product bulk bagging.

Operational costs are very low. The largest unit operates with a 200 kW (275 Hp) drive motor, the smallest with a 22 kW (30 Hp) drive motor. Processing cost per ton will vary with the size of the unit but are considered very low for crushing/separation/screening systems. Custom sizes, throughputs and processing configurations are part of the DIDION philosophy of equipment design and can always be evaluated and normally accomplished. Manpower requirements are also very low. Loading is typically automatically by the in feed vibratory conveyor.

9. Summary

The flexibility of the design configurations of the DIDION rotary processing equipment has many potential applications in the primary aluminum smelter environment. The RT and RS Systems are excellent candidates for retrofit as the process foot print is much smaller than the initial purchased systems with more product efficiency and a higher process quality. These dynamic systems can lower overall processing cost by reducing manpower, maintenance, energy consumption as well as reducing the plant area required for the anode crushing or thimble cleaning.

10. References

1. David Roth and Brian Best, Recycling materials through rotary crushing and materials separation in the aluminum smelter, Paper Al 19–T, ISCOBA 2012, 29 October – 2 November 2, 2012; Belem, Brazil.