

Recycling materials through rotary crushing and material separation in the aluminium smelter

By **David J Roth***

There are many areas in the aluminium smelter operation that can benefit from efficient recycling of materials through a low cost, simple, rotary impact processing operation. DIDION has developed uses and applications for rotary crushing/separation systems for the recycling and recovery of dissimilar materials that are often physically 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 mould pieces in which they were created. These hot, heavy castings required the development of a very durable machine that operated 24 hours a day, seven days a week.

The continued improvement of the DIDION RT/RS TUMBLERS has made mechanical processing of mixed materials a cost effective and low maintenance alternative to other types of processing systems. These systems can perform surface scrubbing, crushing, screening and sizing in one single piece of equipment.

The RT/RS TUMBLER is a single processing unit that can perform multiple processing steps within one piece of equipment. This is achieved through the patented double liner configurations. The system requires very low levels of manpower.

This operating philosophy makes the DIDION systems suitable for the primary aluminium smelter where the attention should be focused on making aluminium and not problems with ancillary equipment.

Basic design features

There are four basic features of the DIDION RT Rotary Processing Systems.

- First the ability to process very large pieces of feed in the same processing step as fines separation, up to 1750mm blocks.
- Second, the ability to crush with controlled fines generation.
- Third, 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.
- Fourth, the ability to classify up to eight sizes of material from bag house dust to 1750mm in the same single piece of equipment.



Model RT 84-2100 DIDION scrubber/crusher/seperator

Summary of primary aluminium plant applications for the RT TUMBLER processing system

- Rotary Bath Crusher and size separator in a single process with the ability to remove the tramp aluminium from this electrolyte in the same step.
- Carbon Reclaimer and Cleaner, scrubbing the bath off used carbon blocks before crushing and recycling and then crushing to the required size in the same piece of equipment.
- Removal of carbon and bath from cast thimbles in the anode rodding shop saving consumables and floor space over traditional shot blast methods and cleaning of pig iron in the same step.
- Separation of metallics from oxides and salts in dross and salt cake processing, with a significant environmental impact in the elimination or reduction in landfill materials.
- Spent Pot Liner crushing and metallic material separation.

Crushing of large blocks of material:

Handling large blocks of material can be particularly difficult for most processing systems. However, these must be reduced in size if they are going to be recycled.

Most systems either use a primary jaw crusher or a mobile hydraulic hammer/crusher for this first breaking step. The RT Systems handle this in the first section of the drum, taking this time consuming and often-dangerous manual

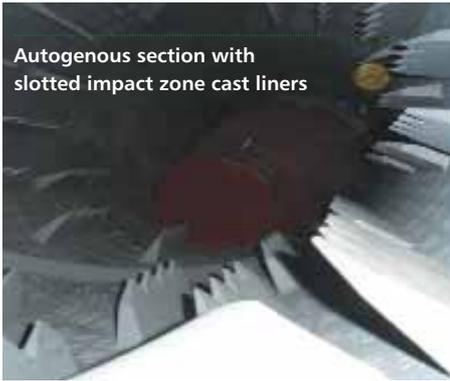
labour step out of the procedure. The material is normally charged by end loader into a large hooded vibratory feeder, that loads the DIDION drum. Large cast steel teeth lift the blocks and then crash them down on hardened spikes for an impact and autogenous milling step that can handle any material used or produced in the smelter. Solid aluminium sows can be inadvertently charged into this section of the drum when processing dross for example and will not cause any damage to the DIDION unit. Large un-crushable pieces such as large slabs of aluminium can be removed from the machine simply by backing out the feeder and reversing the rotation of the drum, discharging these large pieces into a waiting tub. This practice causes no damage to the equipment, which is often the case with impacting systems.

This is a valuable feature in bath, pot cleanings and dross processing applications. Allowing one piece of equipment to handle these large pieces without disrupting the process flow is unique to this material's processing steps.

Crushing with controlled fines generation

The impact action of the material falling on the cast steel flights in the pre-breaking and autogenous chambers combined with the action of the muller roller allow for severe crushing, while also immediately removing the fines that are generated in

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Autogenous section with slotted impact zone cast liners



Spent Anode with Bath



Clean RS processed thimbles

the process is critical to achieving process success. The key technical challenge that the RT unit accomplishes is both preserving the preferred crushed material sizing that was chosen to go thru the liners and the removal of finer materials that act as a cushioning bed lowering the efficiency autogenous impacting.

This characteristic becomes valuable while processing recycled carbon anode pieces for the downstream processes. Preselecting the correct liner opening and screen size determines the distinctiveness of the materials, accomplishing the generation of the appropriate sized fines for further processing in the green carbon plant. This normal multiple step process is not complicated with the RT/RS system.

The size control abilities of the RT can reduce the large blocks to the exact fraction sizes that are required for use in recycling these materials. The impact breaking action of the system gives sharp fracture angles on the particles, which are preferred for the green carbon recycling process.

This impact crushing characteristics of the system also works for recycled bath processing, allowing for product sizing and for the removal of tramp ferrous metals and aluminium. The RT system provides a uniform product to put back on top of the pot cells.

“Scrubbing” surfaces removing materials that are foreign to the base structure

The interior design of the DIDION RT systems can allow for multiple sections accomplishing a variety of processing goals. The scrubbing or removal of foreign material from the base material is a standard application for DIDION rotary equipment. In the original foundry applications for the units, it was the removal of sand from the base casting.

In the case of removal of the bath from the anodes or carbon from the thimbles the standard practice of shot blasting is inefficient and time consuming. The steel shot is an expensive consumable that can be carried over into other aspects of the process. The cleaning efficiency of that system is not perfect and significant

amounts of sodium/bath contamination can move to the next phase of the process.

These salt contaminants typically cause problems with the refractories in the carbon backing furnaces and in the thimble casting furnaces. The RT/RS processing technique stops the majority of the bath and carbon carry over into the next part of the production process improving if not eliminating the furnace refractory issues.

Classify several sizes of material in the same processing step

The numerous DIDION patents for this piece of equipment allow for this very significant trait of the RT & RS processing units. There are advantages from both a process viewpoint and from a general economics view point of being able to accomplish many processing steps in one unit.

The process advantages that provide the abilities of this unit are:

1. The ability to take almost any size initial feed. The only restriction being the selection of the overall diameter of the unit. Systems are available in diameters up to 4.5 metres. The unique reversing feature of the system with the units incorporating the primary impact chamber allow for solid aluminium to be processed cleaned and discharged into tubs after retraction of the entry feeder. Typical block size here is + 250mm.

2. The coarse and fine particle removal is the next stage that can be key to the value of the materials in processing dross and the efficiency of the process with the autogenous impact designs. The screens in this area can be any opening less than the liner holes. This hooded area is designed for two screens that allow for different opening sizes in each panel. These screens can quickly be removed and changed for other sizes if downstream process parameters change requiring different fractions of fines materials. Typical fines screen selection will range from -10mm to + 3mm.

3. The ability to select recirculation or direct discharge in the machine of the intermediate materials classified by the liner holes is important for processing flexibilities. In bath carbon processing it

can control the size and characteristics of the particles moving forward to the next process step. When processing materials that contain metallic aluminium, this element allows for high concentration of metallics that can be efficiently melted or sold for high metal contents. The liner holes/slot sizes typically range from 10mm – 50mm.

4. The autogenous milling section will reduce friable materials down to the size of the liner openings. None friable or metallic materials can then exit the back end of the drum. These materials usually will be - 250mm + 50mm. They can be further sized with a rotary classifier attached to the end of the drum into three additional cuts depending on customer requirements.

5. The air flow of the bag house system provides the final product sizing possibilities. The pollution control device normally removes -.5mm materials. This fraction can be subdivided by use of a cyclone separator before the bag house.

All of these sizing steps occur inside the DIDION system. Providing products that can be recycled as is or moved on further for use in the green carbon plant or bath to be reused in the pot lines. Environmentally the dust is strictly controlled by the bag house/pollution control system installed with the unit or attached to the smelter plant system.

Summary

The flexibility of the design configurations of the DIDION rotary processing equipment has many potential applications in the aluminium smelter environment. The largest unit operates with a 200Kw drive motor, the smallest with a 22Kw drive motor. Processing cost per ton will vary with the size of the unit.

These systems can lower overall processing cost by reducing manpower, maintenance, energy consumption and lowering the plant area required for the above-mentioned materials processing practices. The additional benefit of improving the recyclability of the dross and other aluminium containing materials is in addition to reducing landfill cost and the generation of green house gasses. ■