Multi-Stage Particle Size Crushing and Storage-Transportation System for Spent Anodes

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Abstract

In the aluminium industry, butts recycling is a crucial yet challenging process. The traditional treatment is suffering from technical issues like uneven particle sizes, severe dust pollution and inadequate automation, which hinder resource recovery and endanger environment and workers' health. To address these challenges, this paper presents an integrated butts treatment system featuring multi-stage crushing, efficient dust collection, and intelligent conveying. The system enables precise control over the whole butts treatment process from crushing to storage-transport by employing 3-stage crushers for various sizes (coarse, medium, fine) with bag filters and automated conveying units. The results show significant improvements in the process efficiency and quality, reduced costs, supporting the industry green and intelligent transformation.

Keywords: Aluminium smelting, Prebaked anodes, Butts, Crushing, Transport.

1. Introduction

1.1 Industry Background and Issues

From a fundamental industry with high energy consumption and heavy resource dependence, aluminium smelters have long struggled with the treatment of butts (spent anode carbon blocks after electrolysis). Traditional butts treatment typically employs single stage crushing where after pressing, butts are fork-lifted from the dumping site to jaw crushers. The open-type process lacks effective dust control, causing dust levels of workshops to exceed standards by 10–15 times, severely endangering workers' health. High manual involvement and poor equipment integration limit efficiency, failing to meet modern large-scale production demands. Some smelters even directly sell butts for new anode carbon blocks, leading to low recovery efficiency of spent anodes and inevitably increasing operational costs. In China, butts were usually discarded in the past, but recently there is a tendency to fully recycle them for use as anode raw materials [1].

1.2 Research Objectives and Significance

Based on the experience from an aluminium smelter abroad, this paper describes an intelligent butts treatment system integrating crushing, storage-transport and dust collection. It achieves uniform particle size via multi-stage crushing, boosts efficiency with automation, and improves the working environment through efficient dust collection. Its application enables a shift from extensive to refined butts treatment in the aluminium industry, achieving closed-loop anode utilization and reducing workshop dust to below 10 mg/m^3, with significant economic, environmental and social benefits.

2. System Architecture and Technical Principles

The multi-stage butts crushing and storage-transport system adopts a modular design, comprising three core modules: pressing and crushing, storage-transport, and dust collection, integrated with an intelligent control system. These modules operate in coordination via sensors and PLC control. The overall process begins with a primary crusher, followed by a conveyor belt transferring butts to a medium crusher for further size reduction. The crushed material is then conveyed to a fine crusher for final processing. Dust generated at each crushing stage is collected in real time by bag filters. The materials that meet the particle size requirements are then transported to the butts silo through the automated storage and transportation system. Below the silo, a belt weighing feeder and an automatic telescopic chute enable automatic weighing and controlled unloading of butts, which are then loaded into tank trucks for delivery to downstream production areas. Figure 1 shows the system's process flow diagram.

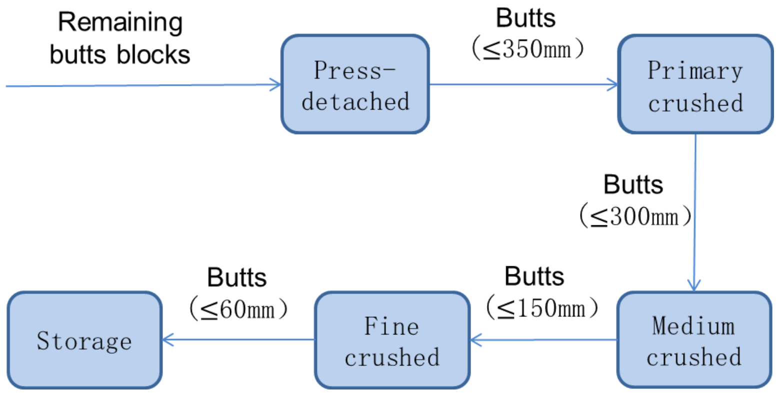

Figure 1. Process flow diagram of butts crushing.

2.1 Butts Pressing and Crushing Process

2.1.1 Butts Pressing Process

See Figure 2 for the butt pressing process. Laser or ultrasonic probes automatically determine the height of the butts. Based on the results, the PLC controls the conveying system (such as chain conveyors, pusher mechanisms, or robotic arms) to direct the butts to the corresponding press:

- Large butts: fed into a dedicated large butt press (higher pressure, slower speed);
- Standard butts: fed into an automatic butt press (standard pressure, high speed).

5.2 Technical Outlook

Future system optimizations may include:

- Addition of a material screening system: to classify and store butts based on different particle sizes, thereby meeting various production requirements.
- Incorporation of a vision recognition system: to automatically detect and intercept oversized butts and return them to the crusher for reprocessing.
- Deployment of AGV intelligent robots: to swiftly clear blockages at the crushing station and restore normal operations in case of material jams.

6. References

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