Advanced Process Control for Wet Grinding Circuits: Unlocking the Potential for Throughput Improvement and Energy Savings in Ball Mils

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Abstract

Volatile market conditions, price fluctuations, variability of bauxite ore, increasing focus on energy savings and efficiency has pushed the alumina industry to achieve higher production with maximum efficiency. Increased market competitiveness, increasing commodity process, volatile coal prices and quality and tighter emission standards mean production and processing method must be modified to reduce energy consumption and lower carbon dioxide output. Data driven technologies – AI/ML, **Robust Multivariable Predictive Control Technology (RMPCT),** mobile based apps, automation and robotics, the Internet of Things (IOTs), modern data architecture (including the Cloud) can provide solutions to many such problems and open a plethora of potentials to unlock the true value of any operation/process. Milling operations contribute to a larger extent of energy usage in any alumina refinery and improving the process control strategy in this area can significantly improve the productivity of the asset and efficiency of the process. This paper outlines the development and implementation of an advanced control and optimization technology in Milling circuit in Vedanta Lanjigarh with an understanding of the design considerations and potential of the unit along with the current and future operating constraints of the unit.

Keywords: Robust multivariable predictive control technology, Advanced predictive control, Ball mills, Feedback control loops, Feed forward signal.

1. Introduction

Volatile market conditions, price fluctuations, variability of bauxite ore, increasing focus on energy savings and efficiencyhas pushed the aluminaindustry to achieve higher production with maximum efficiency. Advanced process control (APC) for grinding is one important tool to operate this most energy intense area in an optimal way, finding the optimal trade-offs between highest throughput, energy efficiency based on variable ore properties, production targetsand management priorities.

The Main objective of Bauxite grinding area is to increase the surface area of the bauxite by reducing the size of the bauxite particle to 1.2mm. The size specification of the output is D80 = 812 microns & D50 = 350 microns. Grinding unit is a closed-circuit wet grinding process. Main inputs to the grinding unit are bauxite & test liquor.

Bauxite of size (<25mm) coming from crushing unit is stored in bauxite storage bins (silos). Then from Silo, bauxite is fed to Ball mill through Mill feed conveyor by controlling the speed of the Apron feeder as per the required bauxite flow. Test liquor is also added to ball mill to ensure optimal slurry density within the mill to maximize the grinding efficiency. The mill grinding media is comprised of high chrome balls of varying diameter from 30 to 90 mm. After grinding inside the Ball mill, slurry density of 1050-1150 gpl solids exits from the mill via a chute into the

Figure 1. Ball Mill.

trommel screen.The trommel screen has an aperture of 8 mm & is sized to allow only ground bauxite to pass through the mesh to discharge tank. Any unwanted particle such as small broken balls, mill scats is ejected into a scat bin for disposal. Then the bauxite slurry from discharge tank is pumped to the Vibrating screen through mill discharge pumps. The rapid vibration of the banana screen allows the correctly sized slurry to pass through the screen without any choking. And oversized particle again returns to the mill via a chute for further grinding. The correctly sized particle (1.2mm) flows via an underflow chute to the final product tank. Then from the final product tank slurry is transferred to the pre-desilication area through product pumps. There is also provision of addition of test liquor in Mill Discharge tank to ensure the required slurry density (720gpl). And a small amount of test liquor is also injected into the underflow chute of the banana screen just to assist the slurry flow & to prevent choking.

2. Bauxite Grinding Operation Overview

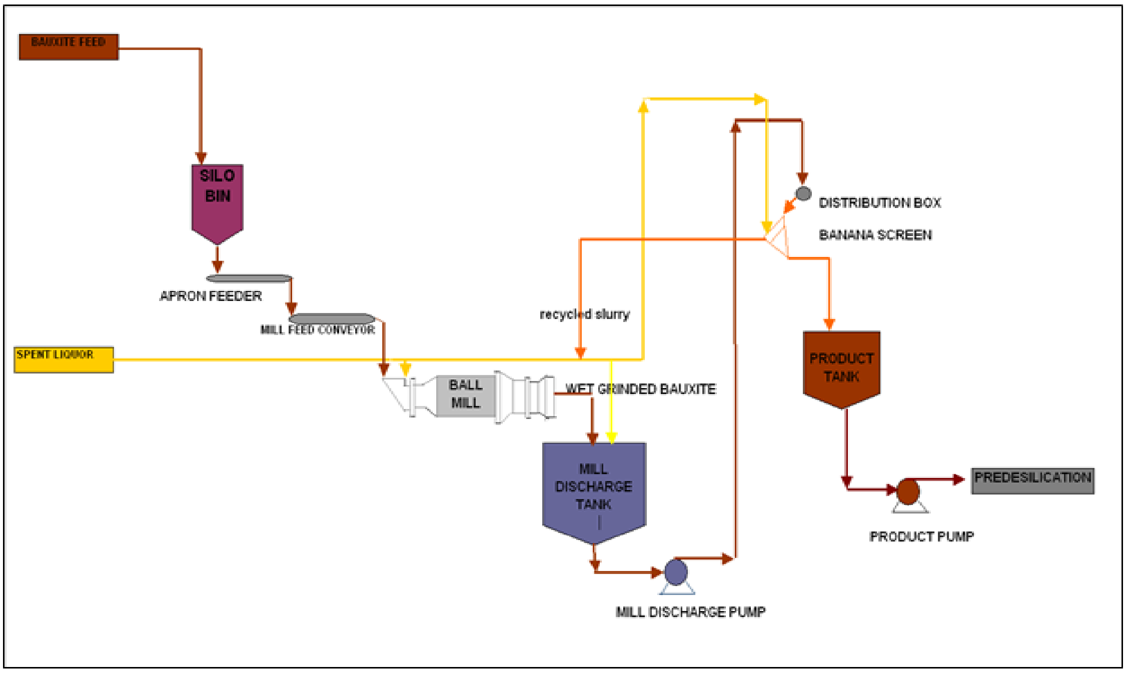

Figure 2. Ball mill grinding circuit PFD.

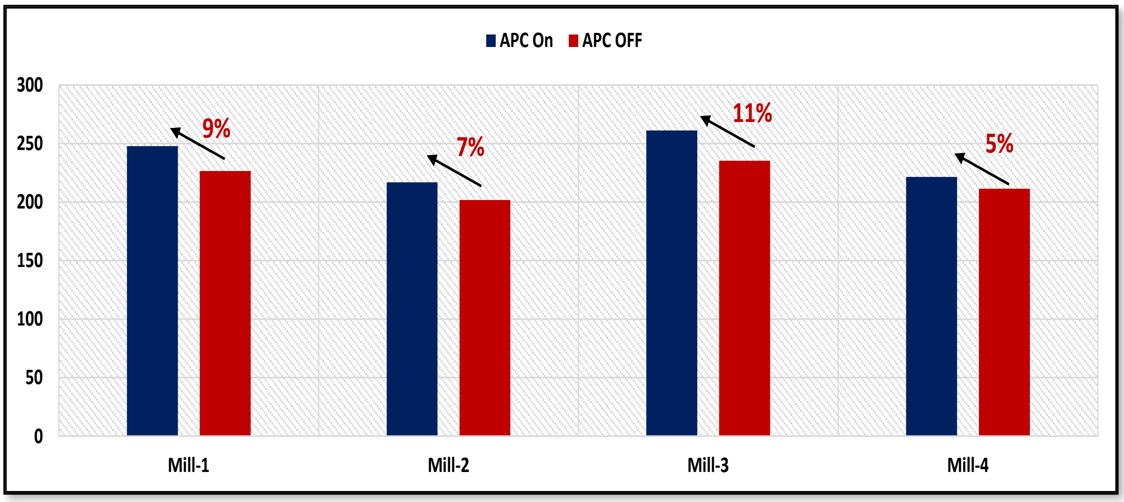

Figure 7. Actual throughput improvement in mills.

The throughput enhancement in the mills led to reduction in the specific energy consumption of the Mill.

4. Conclusion

Advanced process control has several advantages like improved production capacity, minimized power consumption, lower feedstock variability to downstream units, better analysis, and modification of operating objectives as per new requirements, improved monitoring of key performance indicators, increased process safety, reduction in process setting time, increase in equipment reliability, and better operational understanding of the unit over conventional process control technology. Use of advanced process control software allows monitoring of process parameters at a granular level as compared to normal process control technology. This allows for better monitoring of process parameters and helps in predictive maintenance of the system. With more stability, all plant equipment can be operated efficiently, leading to an increase in the production capacity and thus, plant profitability.

5. References

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