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Optimization of an Iron Ore Washing Plant

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Abstract

The sustainable viability of a mineral enterprise depends on improving the concentrate quality, generating readily salable by-products, improving recovery, throughput, and reduction of unit cost rate and maximize the unit income rate and thereby unit profit rate. Closing down of iron ore mines due to environmental constraints spurred the captive iron ore washing plants to work on a custom plant mode and also recover the values from their slimy tails. This paper enumerates the difficulties faced by a captive iron ore fine washing plant [treating iron ore fines assaying Fe~58% yielding sands assaying Fe>60%] due to raw material change yielding unsalable sands and discuss the importance of process plant audit for improving the mineral processing plant performance. Based on the base line study, laboratory tests on typical samples followed by short term modifications, retrofitting of downstream slime concentrating wet high intensity magnetic separators and dewatering of products could produce readily salable sinter grade [Fe>60%] and pellet grade[Fe>62.5%] with an overall increase of concentrate yield by 11.5%. Even the previous wash plant tails [which assayed Fe > 45%] may be reprocessed in the retrofitted slime processing VPWHIMS plant. The final tails assayed 38.60% Fe at weight % yield of 28.5. Efforts are on for utilizing the above tails in bricks- tiles manufacture. Also, R&D efforts to concentrate Fe values from above 38.60% Fe tails by Magnetizing roast followed by magnetic separations in bench scale has given encouraging results. Thus auditing not only improved the quality, quantity and rate of production of concentrate but mitigated the problem of tailing disposal. The investments were repaid within a year of operation and unit operating costs reduced by 20% with reference to base line data.

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Key words; Process audit, iron ore slime processing, WHIMS

1. Introduction

The viability of a mineral enterprise necessitates the development of specific techno-economic model for optimum operations. The co-dependence of ore variability - process variables, interdependence of different operations in a mineral enterprise, non-quantifiable factor needs continuous monitoring. This continuous monitoring and generation of a dynamic techno-economic model is difficult. Hence, practice of improving viability by maximizing recovery and productivity seems unsustainable, till significant overall unit cost rate reduction and enhancement of overall unit revenue and profit rate is achieved. The performance improvement of the plant needs the routine auditing studies for reducing the overall unit cost and to improve the cash flow. The literature review on iron ore dressing plant performance improvement studies by auditing are limited except the works of Malhotra (2000), Rao et.al. (2002), Ravindranath et al.(2005), Louis et.al. (2010) and Rudrappa et.al(2013), Ravi et.al.(2013). Audit is defined as a formal, thorough and periodic examination –

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evaluation of a system. The present paper deals with metallurgical process audit and its role in plant overall performance improvement in the case of few iron ore dressing plants of Bellary region.

2. Process auditing

The aim of process auditing is to understand the effect of the process variables on the profitability. Table 1 denotes the steps and outline of process auditing as enumerated by D Malhotra (2000). The auditing job is complicated due to ore variability, mismatched equipment, changing market specifications, enforcement of stringent environmental guide lines and cost escalation due to inflation as enumerated by previous works [1-6]. The performance improvement studies by process auditing are demanding from time – economic viewpoint. Sometimes it is frustrating due to ill-defined objective, improper problem identification and lack of will for implementation. It is a tough job as conceptual ideas have to be sold enumerating the costs, time and risk factors with relation to the benefits obtained. The problem compounds if the historical data is improperly logged and sampling points in the circuit are improperly located. However, the total involvement of plant team with proper communications is the key to solve the teething problems associated with auditing. The data is analysed logically, scientifically and statically keeping techno-economics in view. Once the problem is identified, test works under simulated conditions based on evolutionary and revolutionary concepts are conducted. Conclusions are drawn evaluating the alternatives for solving the problems. The recommendations are made based on sustainable benefits. After on-site implementations, circuit is sampled, the results with techno-economic benefits are evaluated with reference to base line and projected values. Recommendations for improvements are suggested.

Table 1. Outline of steps in a metallurgical process auditing [1]

Outline of steps
Define project objective
Check the objective
Identify the problem
Review the historical and design data
Designing the sampling campaign
Sample the unit operations/circuit
Logical data analysis and base line data preparation
Test work in simulated conditions-evolutionary and revolutionary concepts
Techno –economic evaluation of alternatives, comparing with similar industrial data base
Recommendations, on site implementation and evaluation
Conclusions

3. Performance improvement by auditing of iron washing plant

The flexibility of process auditing for diverse cases to improve the overall performance of plant from techno-economic view point are discussed below. The program objectives vary due to the time, money and operating philosophy constraints of the company. The process auditing has to be flexible to cater the present needs in stages with an integrated approach in future. An iron ore washing plant near was washing crushed / natural iron ore fines to obtain +60% Fe grade concentrate with 10% not exceeding +10mm and -0.1 mm size. The process comprised of drawing the ore from bin via feeder at 100 tph and fed to screen for removing 10mm over size. The screen under size and water was added to the feed port of 0.48 m dia spiral classifier by passing a drum scrubber. The reason for circumventing drum scrubber was to reduce the energy cost and bottleneck due to maintenance of rollers of scrubber. The 0.48 m dia classifier was flared over flow type with 0.72 m wide and 120% via submergence at maximum weir level and 70% submergence at minimum weir level. The spiral was twin pitched with pitch of 0.25 diameter. The rpm of spiral was found to be 6. It was reported that the washability performance of classifier was poor. The iron ore fines assaying 54.40% Fe, 9.53 % SiO_2, 5.88%Al_2O_3 and 4.77% LOI when treated, yielded muddy classifier sand assaying 56.40% Fe, 8.33 % SiO_2, 5.08%Al_2O_3 and 3.77% LOI with 62.2% Fe distribution at wt% yield of 60. The slimy tails assayed 52.77. As the product failed to meet the specified grade of +60% and exceeded the 10% limit for -0.1mm size, the company requested for a plant performance improvement study.