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Research article

Optimizing Hydrocyclone Placement in Grinding Circuits of Lines 5, 6, and 7 at Golgohar Iron Complex Using USIM PAC Software

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English Extended Abstract

Summary

Modeling and simulation play a crucial role in designing, developing, and optimizing processing circuits, enabling accurate prediction of their behavior and performance. Lines 5, 6, and 7 of the Golgohar plant are similar, each receiving feed from the No. 3 Golgohar mine. The high concentration of fine particles in the feed to these lines significantly increases the importance of proper hydrocyclone positioning. This research aims to determine the optimal layout for the ball mill, medium-intensity magnetic separators, and hydrocyclones. Two placement options for the hydrocyclone were evaluated: at the beginning or the end of the grinding circuit. USIM PAC software was used to simulate the effect of the hydrocyclone's placement on the milling circuit's performance. The initial step involved defining the key simulation parameters, such as the breakage function, selection function, residence time, and the geometric features of the equipment used. Both the existing circuit (Ballmill-Magnetic Separators-Hydrocyclones) and the proposed alternative (Hydrocyclones-Ballmill-Magnetic Separators) were simulated. The analysis suggests that the existing circuit requires three hydrocyclones operating at 112 kilopascals. Optimal diameters are 260 mm for the inlet, 160 mm for the overflow, and 130 mm for the underflow. The feed, overflow, and underflow particle sizes (d80) are 52, 243, 102, and 321.86 microns, respectively. The proposed circuit incorporates three hydrocyclones, each operating at 134 kilopascals. These hydrocyclones have inlet, overflow, and underflow diameters of 225 mm, 297 mm, and 82.5 mm, respectively. The particle size (d80) of the feed, overflow, and bottom products was measured as 574.25, 104, and 1229.01 microns, respectively. The proposed grinding circuit's input feed saw a 21.69% reduction in tonnage, while particle size increased by 159.03%. The circulating load tonnage, particle size, and outflow particle size from the ball mill decreased by 37.71%, 4.43%, and 8%, respectively. The proposed circuit boosts the capacity and the size reduction ratio of the ball mill by 21.69% and 172.98% respectively. These results confirmed that the proposed circuit has a higher efficiency than the existing one.

Introduction

The efficiency of the Golgohar Iron processing plant's grinding circuit was re-examined due to fluctuating feed characteristics and a high fines content in the feed entering Lines 5, 6, and 7. The mill usually receives feed with a particle size of less than 100 microns, with an average of 20 to 30 percent. The main source of fines in the mill feed is in the crushing circuit, particularly during pre-crushing with a high-pressure roller

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Journal of Analytical and Numerical Methods in Mining Engineering

Journal home page: http://anm.yazd.ac.ir/

mill. To increase plant capacity and optimize particle size for downstream equipment efficiency (magnetic separation), the existing grinding circuit layout was examined, and a new circuit incorporating a hydrocyclone before the mill was designed and analyzed. To investigate this issue, the current circuit (mill-magnetic separator-hydrocyclone) was first modeled, simulated, and analyzed by the USIMPAC software. The design and simulation of a new processing circuit with a hydrocyclone placement before Asia was conducted, and the flow characteristics of the circuit were predicted. Wherever possible, the goal of this research was to use models that have a physically meaningful structure, specifically higher-level USIMPAC models, to obtain the necessary data for the models. At the end, the performance of the present processing circuit was evaluated against that of the new proposed processing circuit.

Methodology and Approaches

To assess equipment performance and obtain model parameters, six sampling stages were conducted during circuit steady state, each lasting 2 hours with approximately 20-minute intervals between samples. To determine the breakage and selection functions, the necessary sampling was carried out to prepare a representative sample, and then these experiments were conducted. Afterwards, caustic soda was utilized as a tracer to obtain the particle residence time distribution in the mill. sampling was performed where feasible, and unknown flow characteristics were inversely calculated using USIMPACK's mass balance algorithm. Each section of the processing circuit was modeled in software and validated against industrial data. The efficiency of the current circuit was then compared via USIMPACK simulation with a proposed circuit that incorporates a hydrocyclone before the mill.

Results and Conclusions

This research aims to optimize the configuration of a ball mill circuit, medium intensity magnetic separator, and hydrocyclone within grinding circuits. The study evaluates the placement of the hydrocyclone at the beginning (current circuit) and end of the circuit (proposed circuit), simulating the impact on performance using USIMPAC software. Figure 1 shows the two flow sheets of the processing circuits. Due to the imposed restriction, the hydrocyclone overflow particle size distribution, with a d80 of approximately 100 microns, remained consistent between the current and proposed milling circuits. Table 1 displays the comparison of d80 and flow rates between the current and proposed circuits. In the proposed circuit, due to the pre-removal of fines, the particle size distribution of the hydrocyclone underflow and ball mill feed is wider than in the current circuit. Removing fines from the ball mill feed resulted in a 21.69% tonnage reduction and a 159.03% increase in the d80 of the feed. By doing this, both the impact force of the grinding media and the residence time in the ball mill will increase. Optimizing the ball mill grinding process resulted in an 8% reduction in the outlet flow's d80 value, a 172.98 increase in the ball mill's grinding ratio, a 37.71% decrease in circulating load tonnage, a 4.43% reduction in the circulating load's d80 value, and a 21.69% increase in ball mill capacity, thereby increasing the overall grinding circuit capacity.

Table 1 - The comparison of simulated values for particle size and flow rates between the present and proposed flowsheets.

Parameter	Present flowsheet	Proposed flowsheet
Fresh Feed (ton/hour)	461	461
Ball Mill Feed (ton/hour)	1268	993
Circulating load (ton/hour)	14.93	9.30
Hydrocyclone overflow, d_{80} (micron)	102.12	104.29
Hydrocyclone underflow, d_{80} (micron)	324.48	1229.01
Ball Mill Product, d_{80} (micron)	250	230.18
Ball Mill Feed, d_{80} (micron)	771.67	1229.01
Circulating load, d_{80} (micron)	13577.04	12975.42
Magnetic Separation Feed, d_{80} (micron)	238.7	229
Grinding Ratio	3.09	5.34

Vol. 15, No. 44, Fall 2025, Pages 13-26

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(a)

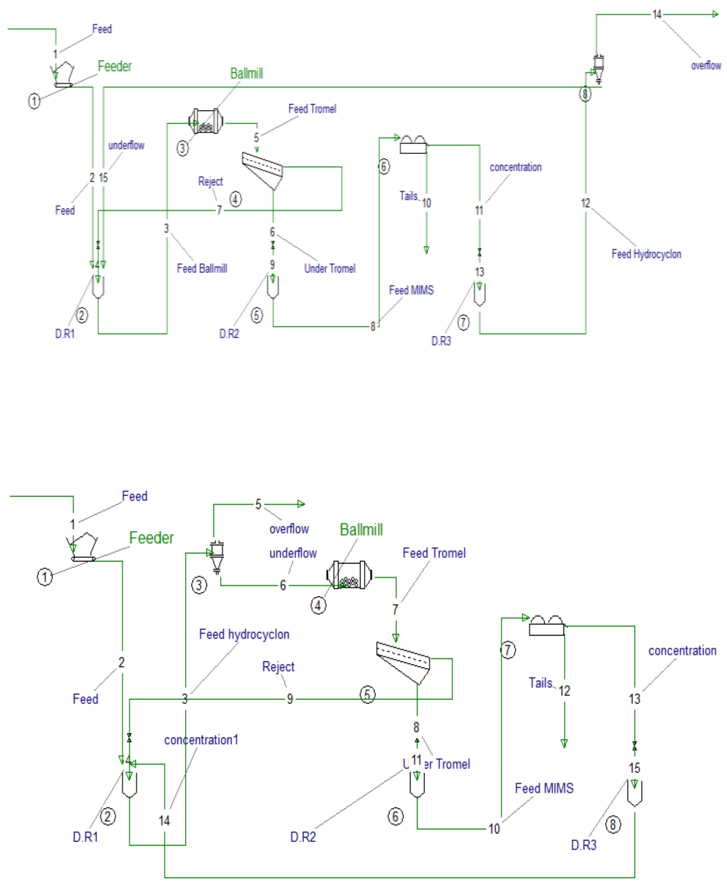

Fig. 1. The present (a) and the proposed flowsheets (b), for Iron processing in the Golgohar plant

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Vol. 15, No. 44, Fall 2025, Pages 13-26

Journal of Analytical and Numerical Methods in Mining Engineering

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