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Research article

Improving the performance of the dynamic air separator of the pelletizing plant of the GoleGohar Mining and Industrial Company

Mohammad Ansari[1], Payman Khademi[1], Amir Ali Pourkhosravani[1], Ali reza Ghasemi[1], Vahid Karbakhsh[1], Samad Banisi[1*]

1- Dept. of Mining Engineering, Faculty of Engineering, Shahid Bahonar University of Kerman, Kerman, Iran

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Keywords

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DEM
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English Extended Abstract

Summary

This study focuses on improving the performance of a dynamic air separator in the pelletizing plant of GoleGgohar Mining and Industrial Company. The research combines simulation tools such as Computational Fluid Dynamics (CFD) and Discrete Element Method (DEM), laboratory measurements, and field observations to analyze the separator's performance and identify operational issues. The study investigates the impact of various operational parameters on the separator's efficiency and sensitivity to each parameter. Two control strategies for adjusting the cage rotation speed were tested, revealing that constant cage speed resulted in a finer product with less fluctuation in the Blaine number in compare with the variable cage speed (from 1154±240 to 1195±72 cm^2/g). The accumulation of fine particles (average size of 7 μm) in the volute chamber was identified, attributed to issues such as improper discharge valve operation, uneven air distribution, and reduced bag filter efficiency. Corrective measures, including adjusting the cyclone discharge valve, repositioning damper plates, increasing air velocity, and modifying the cage guide vanes, reduced material deposition in the volute chamber from 30% to 10% of the cross-sectional area. DEM simulations highlighted the importance of uniform feed distribution on the separator's efficiency, leading to a proposed design modification that improved feed distribution and improved particle distribution relative standard deviation from 30% to 5%.

Introduction

The characterization and performance analysis of industrial equipment in mineral processing plants is crucial for advancing the field, as it provides a deeper understanding of system performance and facilitates process optimization. Dynamic air separators are increasingly used in dry grinding circuits due to their ability to efficiently separate fine particles, which is essential for achieving high product quality and operational efficiency. These separators have evolved through three generations, with the latest high-efficiency separators offering advanced rotor designs, improved air circulation, and better control over product quality and operational parameters.

Previous researches have demonstrated the potential of high-efficiency separators to reduce energy consumption and improve separation efficiency in various industries, including cement and mineral processing. This study aims to provide a comprehensive performance analysis and troubleshooting of a third-generation dynamic air separator used in GoleGohar pelletizing plant. The separator's self-regulating nature, while advantageous for continuous operation, presents challenges in maintaining consistent product quality, necessitating precise control and optimization strategies.

*Corresponding author: E-mail: *banisi@uk.ac.ir*

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Methodology and Approaches

The study employed a multi-faceted approach to analyze and optimize the performance of a dynamic air separator. A detailed 3D geometric model of the separator was developed using SolidWorks™, based on technical drawings provided by the manufacturer. This model served as a foundational tool for understanding the separator's internal structure, enabling accurate Computational Fluid Dynamics (CFD) and Discrete Element Method (DEM) simulations. DEM simulations were conducted using an in-house developed software package (KMPC-DEM) to analyze the distribution of materials on the distributer plate, focusing on achieving uniform material flow to enhance separation efficiency. The simulations revealed challenges in maintaining uniform distribution, leading to the proposal of a modified distributer design to improve performance.

CFD simulations, performed using Ansys Fluent™, investigated airflow patterns within the separator's volute chamber and dampers. The Reynolds Stress Model (RSM) was used to capture turbulent and swirling flows, with boundary conditions set to replicate real operational scenarios. The results, including velocity contours and pressure fields, were correlated with field observations to identify areas of material accumulation and wear, guiding design modifications to optimize airflow and reduce wear.

Field monitoring and measurements were conducted to validate simulation results and assess the separator's performance. Physical inspections, imaging, and sampling were used to track wear patterns, material accumulation, and operational changes. Particle size analysis, using sieve analysis, cyclosizer testing, and laser particle size analysis (LPSA), provided detailed insights into material distribution and separator efficiency. Pressure monitoring, using a calibrated pressure gauge, helped evaluate the impact of damper settings and airflow variations on separator's performance. These combined methods provided a comprehensive understanding of the separator's operation, enabling targeted optimizations to improve efficiency and reliability.

Results and Conclusions

The study through the investigation of operational parameters revealed that maintaining a constant cage speed led to higher fluctuations in product fineness, whereas implementing a variable-speed strategy significantly improved product stability, increasing the Blaine number from 1154 ± 240 cm^2/g to 1195 ± 72 cm^2/g. These findings highlighted the importance of precise control strategies in achieving consistent product quality.

Field inspections identified excessive fine particle accumulation in the volute chamber, with an average particle size of 7 μm. This issue was attributed to improper cyclone underflow discharge mechanism, suboptimal damper configurations, reduced bag filter efficiency, and non-uniform airflow distribution caused by incorrect guide vane settings. A series of corrective measures, including optimized damper arrangements, improved dust collection efficiency, and guide vane modifications, reduced material accumulation in the volute chamber from 30% to 10% of its cross-sectional area.

DEM simulations indicated that the initial feed distribution on the distributor plate was non-uniform. A modified distributor design was proposed, which significantly improved feed uniformity. It was testified by the reduction of the relative standard deviation of particles distributed around the plate from 30% to 5%, ensuring more consistent particle interaction with aerodynamic forces and enhancing overall separation efficiency.

Overall, this research demonstrated that a systematic approach combining computational modeling, experimental validation, and field observations can effectively optimize separator performance. The findings provided valuable insights for improving classification efficiency, reducing material buildup, and stabilizing product quality in industrial dry grinding circuits.

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Figures and Tables

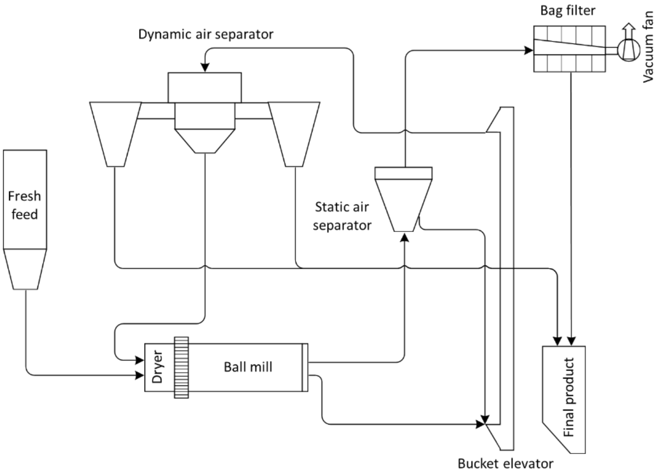
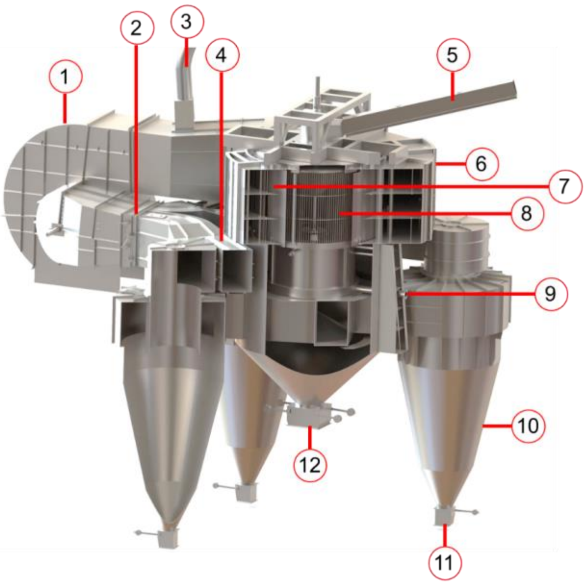


Fig. 1. The grinding circuit of the GoleGohar pelletizing plant



1- Fan	2- Damper	3- Dust Collection Pipe	4- Cyclones Overflow
5- Feeding Duct	6- Volute Chamber	7- Guide Vanes	8- Rotating Cage
9- Fresh Air Inlet Pipe	10- Cyclone	11- Cyclone Pendulum Valve	12- Coarse Product

Fig. 2. A cross-sectional view of the detailed 3D model of the dynamic air separator

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