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Editorial

Editorial for the Special Issue: "Physical Separation and Enrichment"

Saeed Farrokhpay

GeoRessources, University of Lorraine, 54000 Nancy, France; saeed.farrokhpay@univ-lorraine.fr

Received: 4 February 2020; Accepted: 8 February 2020; Published: 14 February 2020

1. Introduction

Physical separation methods have been used in mineral industry for centuries to separate valuable minerals from gangues using differences in their physical properties. They have several advantages over other mineral processing techniques due to their high efficiency, low capital and operating costs, no addition of chemicals and consequently, less environmental hazard. They can be applied to ores from mines and tailings or at the recycling stage for scavenging the desired elements. They are also used to upgrade valuable minerals (i.e., pre-concentration) before the main beneficiation process when such minerals are at low grades and their separation would be costly [1], or in purification of flotation products in processing complex ores [2,3].

2. The Special Issue

This Special Issue includes twelve papers from around the world on topics related to "Physical Separation and Enrichment" in mineral processing. These papers discuss the latest findings on using physical separation methods in mineral processing. They include papers discussing gravity and magnetic separation, hydrocyclones, screens, dry separators, scrubbing, and application of physical separation in processing complex orebodies.

Gravity concentration is one of the oldest industrial methods which is widely used for mineral separation. Its importance has not decreased in the 21st century even with the invention of froth flotation. In this method, gravity, or centrifugal force, is used to separate mixed particles either in suspension or in dry form. A comprehensive review of gravity separation was recently published [4]. Magnetic separation also uses the magnetic properties of different minerals, and the most common application of this method, as one may expect, is separation of iron and iron-bearing minerals [5]. In this Special Issue, Tripathy et al. [6] discuss improving the quality of ferruginous chromite concentrates using gravity and magnetic separation. The value of chromite ores is determined by their iron and chromium contents. Therefore, reprocessing chromite concentrates by physical separation to enhance the chromium-to-iron ratio is an important issue which is covered in this paper. Zeng et al. [7] also discuss selective capture of magnetic wires in high gradient magnetic separation which achieves an effective separation of fine weakly magnetic minerals using numerous small magnetic wires. In addition, Kim and Jeong [8] also used a magnetic method to separate rare earth elements in a deposit in North Korea. Rare earth elements have vital applications in modern technology, and their importance is continuously growing in the world.

Hydrocyclones are devices that can effectively separate multi-phase mixtures of particles with different densities or sizes based on centrifugal sedimentation principles. Traditional hydrocyclones can only generate two products with different size fractions after one classification which may not meet the requirements for the narrow size fractions in fine particle classification. Therefore, Zhang et al. [9,10] discuss multi-product hydrocyclones via numerical simulation of flow field characteristics and separation performance tests of multi-products, as well as numerical separation and experiments of four product hydrocyclones. Their simulation results showed that, in contrast with the traditional

single overflow pipe, there are two turns in the internal axial velocity direction of the hydrocyclone with the double overflow pipe structure. Zhang et al. [9,10] provide evidence for understanding the flow field distribution in hydrocyclones and the development of multi-product grading instruments in terms of both theory and industrial applications. Jiang et al. [11] also discuss the effect of inlet velocity on the separation performance of a two-stage hydrocyclone. The entrainment of coarse particles in overflow, and fine particles in underflow, are two inevitable phenomena in the hydrocyclone separation process which can result in a wide product size distribution. Hence, this study proposed a two-stage hydrocyclone, and the effects of the inlet velocity on the hydrocyclone were investigated using computational fluid dynamics.

Screening is a key operation in a crushing plant which ensures adequate product quality of aggregates in mineral processing. It is affected by the relative difference among various properties such as particle shape, size distribution and material density. Davoodi et al. [12] discuss the application of the discrete element method to study the effects of stream characteristics on the screening performance. Discrete element method is a method for analysing the interactions among individual particles and between particles and a screen deck in a controlled environment. This paper demonstrates that denser particles have a higher probability of passage due to their higher stratification rate which increases the probability of contacting a particle with the screen deck.

The effect of the partition plate unit on the separating of fine coal particles in a compound dry separator is reported by Chen et al. [13]. Compound dry separation technology is often applied for the separation of coal of size fractions above 6 mm, and it has not been widely used in finer fractions. In this paper, the effect of partition plate unit's characteristics on both average density of particles in the bed uniformly and the final separation results for fine coal particles are discussed. The results show that characteristics of the partition plate unit had important effects on the separating process of fine coal particles in a compound dry separator.

Du et al. [14] also contributed to this Special Issue by discussing scrubbing and the inhibiting coagulation effect on the purification of quartz particles. The low removal efficiency of fine clay impurities in natural quartz is the main problem affecting the practical usage of this resource. In this paper, a combined physical purification process, including sieving, scrubbing and centrifugation, is discussed to remove the clay impurities. In another paper, Yang et al. [15] discuss the process of the intensification of coal fly ash using a stirred tank.

Application of physical separation methods to process heavy mineral sand in Brazil is discussed by Gonçalves and Braga [16]. They obtained minimum 70% recovery of the desired minerals by using physical separation units (such as a shaking table and a magnetic separator). Wang et al. [17] also studied a gold deposit located in Zambias where most of the gold particles were less than 10 μm. They obtained more than 90% recovery by using a gravity–flotation combined beneficiation process to recover the liberated coarse and fine gold particles. Gravity–flotation combined beneficiation pre-treatment, in fact, provided a feasible method for the complex refractory gold ore.

3. Summary

This Special Issue is a good example of the growing number of technical and scientific activities around the world trying to develop and understand various methods to separate valuable minerals. We hope this issue will shed light on various aspects of physical separation and enrichment and enhance the knowledge and scientific debate in this field of engineering research.

Acknowledgments: The Guest Editor would like to thank all authors, reviewers, the editor Mr. Irwin Liang and the editorial staff of the *Minerals* journal for their timely efforts to successfully complete this Special Issue.

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