Conclusion

Recirculation in the HPGR was found to be a satisfactory process to obtain a BSA increase suitable for pelletizing application. The percentage of particles smaller than 45 µm showed an increase of only 5 percent after the third recirculation cycle and then remained constant until the end of the process. The ballability tests showed good seed formation and steady pellet growth, which is an ideal situation for an industrial operation. Moreover, a higher percentage of green pellets sized between 10 and 16 mm was observed. The high BSA led to a need for more water addition to balance the pellet growth, although during the larger pilot balling the green pellets generated presented a higher plasticity behavior with a higher drop number and, consequently, a higher deformation during the pot grate loading. The fired pellets performed well in terms of CCS in every test with the ore blend ground in HPGR. Although the performance was not followed by the abrasion index, there is an aspect related to pellets underfired in the bottom layer of the pot grate that increases the percentage of pellets with CCS lower than 100 and 78 daN/p, with typically lower resistance to the tumbling. In future studies, the heat pattern shall be adjusted to further improve the temperature in the bottom layer. ■

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A list of references is available in the full-text paper.

Evaluation of engineering controls at bagging operations to reduce exposures to respirable crystalline silica dust

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To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

The U.S. National Institute for Occupational Safety and Health (NIOSH) and the former U.S. Bureau of Mines (USBM) had put significant effort over the past four decades into researching and developing engineering controls and interventions to reduce mine workers' dust exposures during the bagging and palletizing of industrial minerals. Workers who perform the manual bagging and palletizing of 50- to 100-lb bags typically have some of the highest dust exposures of all workers at mining and mineral processing operations. This paper provides an overview of available dust control technologies for bagging operations and presents the findings of a recent case study conducted at four industrial sand operations to identify the current types of bagging and palletizing technologies being used and to evaluate their effectiveness in reducing workers' exposures to respirable crystalline silica dust. An evaluation is also performed to determine if further reductions in respirable dust levels can be achieved by incorporating additional modifications or improvements into the existing technology.

Bagging operations

The process of loading mineral product into various types of bags is normally called bagging. The stacking of these bags of product onto pallets for shipment to customers is typically called palletizing. There are many types of bags used to ship product to customers, ranging from 50-lb bags to more than one-ton bulk bags. Typically, only the smaller bags (100 lb or less) are palletized because the larger bulk bags are individually shipped. Both the bagging and palletizing processes can be performed manually or through some type of semiautomated or fully automated process.

There are two types of bags used when bagging and palletizing 50- to 100-lb bags: open-top and valve. Valve bags have an internal sleeve through which the fill nozzle is inserted prior to the bag being filled with product. Once the bag is filled and it falls from the fill station, the weight and volume of the product inside the bag forces the valve closed. One major dust source associated with valve bags is product blowback during bag filling. During the filling process, the inside of the bag becomes pressurized by the fluidizing air used to carry the product. This pressure is relieved by air and product flowing back out of the bag valve around the fill nozzle. Another major dust source is product spewing from the fill nozzle and bag valve as the bag is ejected from the filling machine, also known as a "rooster tail." Product blowback and product rooster tail during the filling and ejection steps release dust into the air and contaminate the outside of the bags, causing another significant source of dust exposure during bag stacking or handling. Figure 1 shows these major sources of dust during the filling of valve bags.

Early investigations conducted by NIOSH/USBM focused on ventilation, modification of equipment used, and improved housekeeping practices to reduce workers' dust exposures during bagging and palletizing operations [1,2]. This led to the development of multiple control technologies to reduce respirable dust during the manual filling of 50- to 100-lb bags, including bag valve type [3], a dual-nozzle bagging system which utilizes an inner fill nozzle combined with an outer exhaust nozzle [4,5], and an overhead air supply island system (OASIS) designed to deliver an envelope of clean, filtered air to the bag operator [6].

NIOSH/USBM researchers have developed control technologies to reduce workers' dust exposures during the bag palletizing process. These include a bag and belt cleaning device, or B&BCD, designed to reduce the amount of dust escaping from bags as they travel from the bag loading station to the palletizing station [7,8]; a semiautomated bag palletizing system that uses a hydraulic lift table in conjunction with a local exhaust ventilation (LEV) system [9,10]; and use of an OASIS system positioned above the bag palletizing station [11]. These control technologies and others are detailed in NIOSH's *Dust Control Handbook for Industrial Minerals Mining and Processing,* Second Edition [12], which is available for download at https://www.cdc.gov/niosh/mining/works/coversheet2094.html.

Fig. 1 Major sources of dust during valve-bag filling. Left: Product rooster tail. Top right: Product blowback. Bottom right: Contaminated bag.

Fig. 2 Example of sampling racks with one pDR-1000 and three gravimetric sampling assemblies, including sampling pump, respirable dust cyclone and 37-mm filter cassette.

Experimental design

A recent case study was conducted at four separate industrial sand mining operations to identify the current types of bagging and palletizing technology being used and to evaluate the effectiveness of these implemented engineering controls in reducing workers' exposures to respirable dust. An array of dust sampling packages were placed at key locations throughout the bagging operations to provide a valid representation of the amount of dust generated. The sampling packages used to collect dust concentrations consisted of a Thermo Scientific pDR-1000 instantaneous respirable dust monitor collocated with three gravimetric samplers (Fig. 2). The pDR-1000 uses light-scattering technology to provide instantaneous readings ranging from 0.001 to 400 mg/m^3. The monitors were set to take a respirable-dust reading every 10 seconds which was stored in an internal data logger and downloaded onto a computer. The gravimetric assemblies consisted of a 1.7 L/min sampling pump, a 10-mm Dorr-Oliver cyclone assembly and a 37-mm, 5-μm polyvinyl chloride filter. The gravimetric samples were analyzed using the NIOSH 0600 analytical method [13]. Sampling times at each location ranged from approximately 200 to 450 min. Light-scattering readings can be influenced by factors such as particle composition, particle size distribution, and moisture in the air, so a recommended correction factor was calculated based upon the ratio of the average concentration of the three gravimetric samples and the average pDR-1000 concentration collected during the same sampling period [14]. This correction factor was then applied to the individual pDR-100 data.

Conclusions

The main objective of the research effort described in this paper was to determine the types and effectiveness of dust control technologies and interventions currently being used at industrial-mineral bagging and palletizing operations. In the four operations evaluated as part of this study, it was determined that most of the control technologies and interventions that were implemented and being used properly were effective at reducing workers' exposures to respirable dust. Another major objective of this research study was to determine if modifications and improvements can be made to current technology to further reduce dust exposures during these work processes. It was determined that the current bagging and palletizing technologies being used, when combined with known engineering controls, such as LEV systems and plastic striping, were effective at reducing workers' dust exposures. It was also determined that work practices such as good housekeeping, implementing structure ventilation and maintaining equipment can significantly help in reducing dust concentrations at these facilities. Based upon the results of these four evaluations, it appears that the current available dust control technology provides a range of choices that should enable the industry to maintain workers' respirable dust exposures at acceptable levels. ■

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of any company or product does not constitute endorsement by NIOSH.

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Dissolution of silver and gold with sodium hypochlorite and hydrochloric acid in refractory minerals (mangano-argentiferous)

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Keywords: Refractory ores, Silver extraction, Gold extraction, Mangano-argentiferous, Two-stage leaching

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

This study examines a process for the recovery of precious metals from difficult minerals that exhibit refractory characteristics to cyanidation: low extraction of metals and high consumption of leaching reagent. A mineral sample from Monte del Favor Mine, located in Hostotipaquillo, Jalisco, Mexico, was physically and chemically characterized by X-ray powder diffraction (XRPD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), fire assay and atomic absorption spectroscopy (AAS). Two stages of leaching were carried out, first to eliminate manganese from the sample using sodium sulfite (Na_2SO_3) as a reductive reagent along with sulfuric acid (H_2SO_4), and second to dissolve gold and silver with hydrochloric acid (HCl) and sodium hypochlorite (NaClO). The results show extractions of around 96 percent for manganese (Mn), 98.73 percent for silver (Ag) and 83 percent for gold (Au). The usefulness of high acidity and Na_2SO_3 to obtain better results in Mn and Ag leaching are discussed along with the roles that HCl and NaClO play in Ag and Au dissolution values.

Introduction

Direct cyanidation of mangano-argentiferous minerals has been used in many cases without the minerals receiving any pretreatment. However, the process is not efficient enough because silver and gold found in the refractory part of the mineral remain undissolved. Recent research studied refractory ores that were difficult to leach with cyanide and ammonium thiosulfate. In this research a combined process for the initial dissolution of manganese under reductive conditions was carried out, followed by leaching