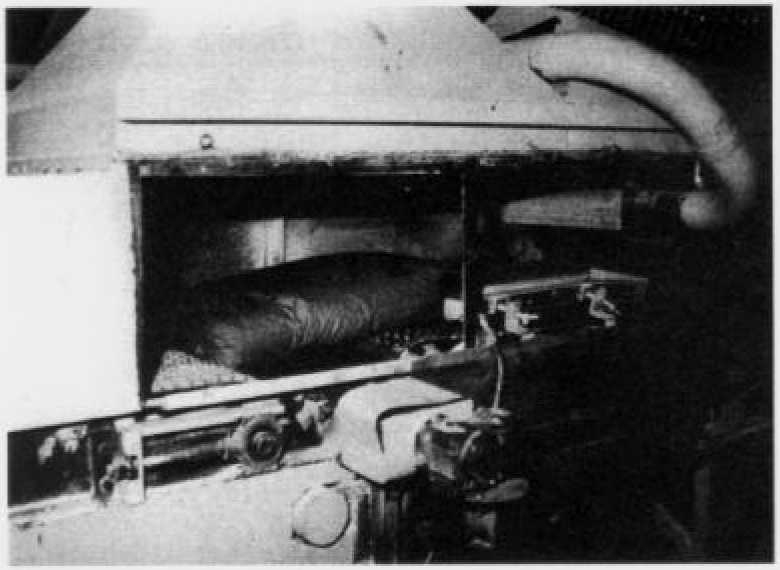
Bag And Belt Cleaner Reduces Employee Dust Exposure



The Bag and Belt Cleaner Device (shown with access panels removed) can handle 50- or 100-lb bags.

by Andrew B. Cecala, Robert J. Timko, and Alexander D. Prokop

Bag loading and stacking processes are the highest dust-exposure job categories in the metal/nonmetal mining industry.[1] To cost-effectively decrease respirable dust levels, the Pittsburgh Research Center of the National Institute for Occupational Safety and Health (NIOSH), formerly of the U.S. Bureau of Mines, designed and tested a system called the Bag and Belt Cleaner Device (B&BCD). The B&BCD is capable of cleaning the surfaces of either 50- or 100-lb bags. A combination of dust-control techniques leave the bag surface and conveyor essentially dust free.

The B&BCD can be placed in the conveyor line anywhere between the bag-loading and the bag-stacking process. Although the original design of the system was to handle 50- or 100-lb bags, it can handle most bag sizes with minor modifications. Cleaning the surfaces of the bags and the conveyor belt greatly reduces dust liberated while the bags are being transported to the bag-stacking location. Ultimately, this reduces the dust exposure for bag stackers, other workers in and around the area, and the end users of the bagged material.

The B&BCD uses a combination of stationary brushes, rotating brushes, and air nozzles to clean product material from the surfaces of the bags and conveyor belt (Figure 1). The B&BCD is 10 ft long and is installed as a part of the conveyor line. As a bag enters the device, it travels through a flexible plastic door where a stationary brush on a swing arm starts the cleaning process on the front and top of each bag.

The bag then travels through a second plastic door and enters the main section of the device where a rotating circular brush cleans the top of each bag. This brush rotates opposite to the bag travel direction, creating additional friction to improve bag cleaning. The sides of each bag are then cleaned by a stationary brush positioned on each side of the chamber. An airjet nozzle is located at the end of each of these brushes.

Each bag should travel through with the valve aligned on the same side of the device for proper cleaning because the valve side of the bag normally is much more contaminated with product than the opposite side. A plastic airjet nozzle delivering 20 cfm of air is used to clean the valve side of the bag. On the nonvalve side, a flat fan airjet nozzle delivering 3.0 cfm is used because it is not necessary, nor cost effective, to use a high-volume airjet nozzle on this side.

The bag then travels over a rotating circular brush located beneath the bag to clean the bottom of each bag. The brush rotates in the same direction as the bag moves because reverse rotation would cause bags to hang up due to the length of the open span, especially with 50-lb bags. The cleaning process is efficient, even with the brush rotation in the same direction as the bag, because the weight of each bag forces it down onto the bristles of the brush.

The bag then exits the device through another chamber, again having two sets of flexible plastic doors. A chain conveyor is used for the entire length of the device to allow product removed from the bags to fall into a hopper located beneath the B&BCD. Product collected in the hopper is periodically recycled back into the process via a screw conveyor.

The B&BCD is a self-contained system that only requires hookups for electricity, compressed air, and exhaust ventilation. Electrical needs include 440 volts, three-phase power drawing approximately 14 amps during normal operation.

Compressed air requirements include supplying the two air nozzles with approximately 23 cfm at 40 psi. In addition, a minimum quantity of air is necessary to periodically change the spacing of the stationary side brushes to accomodate 50- or 100-lb bag sizes. An exhaust-air volume of approximately 1,200 cfm is needed to keep the

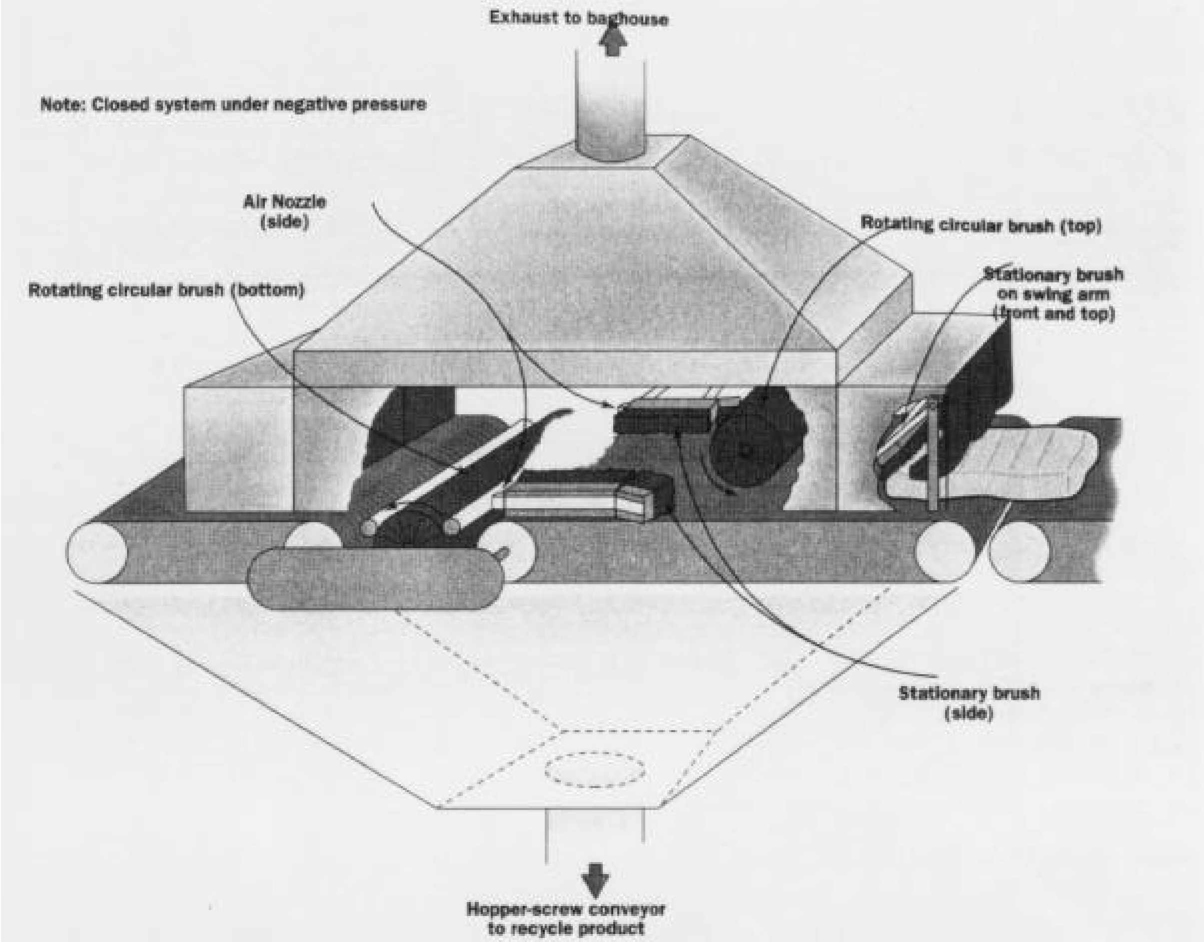


Figure 1: Schematic drawing shows the major components of the Bag and Belt Cleaner Device.

system at negative pressure relative to the surrounding atmosphere. This prevents dust generated within the B&BCD from flowing out of the unit and contaminating the work environment. Because of the quantity of dust being removed, it is recommended that this exhaust air be ventilated into a baghouse.

Put to the test on silica sand

The B&BCD was evaluated at two silica sand plants, both bagging product sized between 120 and 325 mesh in 50- and 100-lb paper bags. The primary goal of each evaluation was to compare respirable dust concentrations with and without the B&BCD.

At the first evaluation site, two bag stackers manually loaded pallets. At the second site, this process was automated using a palletizing machine. The dust-monitoring strategy was similar for both plants. Real-time aerosol dust monitors (RAM-1) were used at various locations around the conveying and bag-stacking process and were considered the primary dust-monitoring instruments. The RAM-1 device uses a 10-mm (0.39-in.) Dorr-Oliver cyclone to classify the respirable dust fraction—particles having an aerodynamic diameter of 10 microns or less.

Another analysis technique performed at both evaluation sites involved removing surface dust from a specific number of bags with a vacuum-cleaning device. This was done to determine the reduction in the amount of product on the outside of the bags using the B&BCD. Ten, 100-lb bags and 20, 50-lb bags were randomly removed from the conveyor line and thoroughly vacuumed. By pre- and post-weighing the vacuum bags on an analytical balance, the amount of product removed from the bags was determined. The effectiveness of the B&BCD was determined by comparing identical product mesh and bag sizes at each site.

The first evaluation was performed by measuring dust levels before (Phase 1) and after (Phase 2) installation of the B&BCD. The entire conveying and bag-stacking area was enclosed with transparent plastic material to minimize the effects of background dust sources. Each phase was performed for five, 8-hr days and measured respirable dust liberated by the movement and handling of bags during the palletizing process.

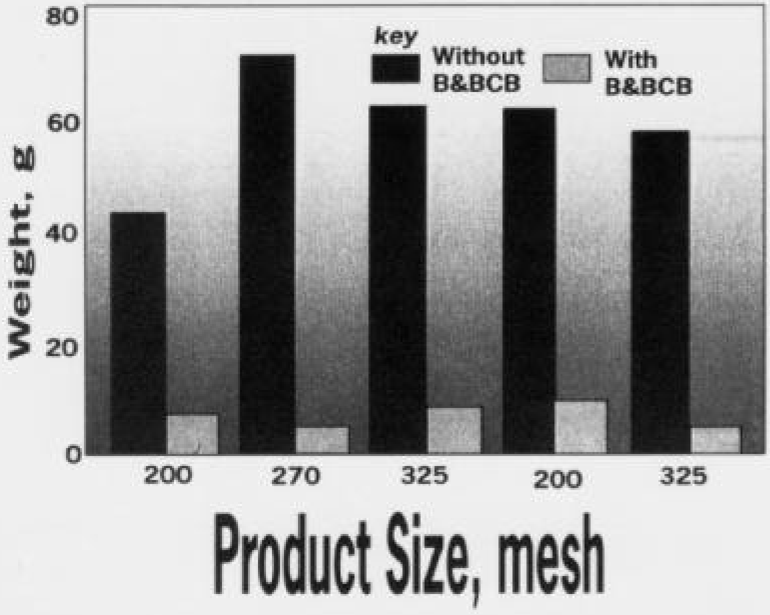


Figure 2: Amount of product removed from the exterior of 50-lb bags by vacuuming, with and without the cleaner device in operation, at evaluation site #2.

Average respirable dust concentrations in Phase 1 ranged from 0.99 to 2.02 milligrams per cu meter (mg/m[3]). In Phase 2, they averaged 0.63 to 1.89 mg/m[3]. The performance of the B&BCD was adversely impacted by an insufficient quantity of exhaust air. As previously stated, the device was designed to operate with an exhaust volume of approximately 1,200 cfm. When the device was originally started, the facility was only able to provide about 475 cfm. An additional fan was installed that increased the exhaust volume to 725 cfm; however, the system was still only operating at 60% of the designed air volume. This deficiency caused the unit to have insufficient negative pressure which resulted in some dust leaking from the device into the work environment.

Bag-surface vacuuming provided the best indication of the B&BCD's effectiveness at the first evaluation site. For Phase 1, the weight gain of the vacuum bag per test ranged from 46 to 171 grams (g). This compared with a weight gain of between 9 and 17 g per run during Phase 2. The reductions in the amount of product on the outside of the bags with the B&BCD were 77.6%, 81.2%, and 89.9% for 200-mesh/100-lb bags, 325-mesh/100-lb bags, and 200-mesh/50-lb bags, respectively. These results were not significantly influenced by the lack of exhaust air volume to the B&BCD and provide a good indication of the reduction in product on the exterior of the bags.

The second evaluation site was at an operation that was making a number of modifications to modernize its ground silica bagging and stacking process. Along with the B&BCD, a new bag-filling machine, a bag flattener, a bag-weighing and printing station, and an automated bag palletizer also were installed. It was not possible to perform pre- and post-installation testing of B&BCD due to these modifications. Because of this, dust concentrations were recorded with and without the B&BCD operating during similar time periods for each specific mesh and bag size.

Testing at this field evaluation site again provided results showing the effectiveness of the B&BCD at reducing respirable dust concentrations. There were three dust-sampling locations in the mill area around the B&BCD to evaluate respirable dust levels with and without the device in operation. These three dust-sampling locations averaged a 24% reduction in respirable dust over the entire evaluation period.

Results obtained by vacuuming the exterior surfaces of the bags also provided a good indication of the effectiveness of the B&BCD. The average weight gain of the vacuum bag per run of product bags before going through the B&BCD was between 43.7 and 72.8 g. This compares to an average weight gain of between 5.3 and 10.7 g per run after going through the B&BCD (Figure 2).

At the second field evaluation site, dust concentration measurements also were taken inside the B&BCD, with and without the device operating. Dust levels were higher with the device in operation because of the dust and product being removed from each bag as it traveled through the device. The increase in dust levels ranged from 180% to 1,000% during operation of the B&BCD. Dust cleaned from the bags within the device means less dust generation and contamination of mill workers after exiting the device.

Throughout this research project, modifications were made to improve the operational effectiveness and safety of the B&BCD. The system has shown itself to be a practical, reliable, and effective technique to clean product bags and the belt at mineral-processing plants, thereby improving worker health. To date, the B&BCD has been in operation for more than three years without significant problems.

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Noted Reference

[1] Watts Jr., W.F,. and D.R. Parker, Quartz exposure trends in metal and nonmetal mining, *Applied Occupational & Environmental Hygiene*, Dec. 1995, vol. 10, no. 12, pp 1009-1018.