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BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cfm	cubic foot per minute	mg/m^3	milligram per cubic meter
ft	foot	mm	millimeter
ft/min	foot per minute	μm	micrometer
in	inch	pct	percent
lb	pound		

PALLET LOADING DUST CONTROL SYSTEM

By Andrew B. Cecala[1] and Anthony Covelli[2]

ABSTRACT

The Bureau of Mines has developed a pallet loading dust control system designed to lower the dust exposure of workers during the bag stacking process at mineral processing facilities. The system makes bag stacking much easier because the pallet height remains constant throughout the entire bag stacking cycle through the use of a hydraulic lift table.

The system uses a push-pull ventilation technique to capture the dust generated during bag stacking. A low-volume, high-velocity blower system operating at approximately 150 cfm blows a stream of air over the top layer of bags on the pallet. The blower system is composed of two 3-in air jets (approximately 1,200-ft/min velocity) directed toward an exhaust system on the opposite side of the pallet. As these air jets travel across the pallet, they entrain the dust generated during bag stacking. The exhaust ventilation system pulls approximately 2,500 cfm of air and dust through the exhaust hood. This exhaust air can then be dumped into a baghouse ventilation system, or filtered before being discharged outside the mill.

During a laboratory evaluation, a 70-pct dust reduction was recorded for the bag stacker. The system was then evaluated in an actual working environment. The first field evaluation was performed at a silica sand operation in which one worker performed the entire loading and bag stacking process. This worker's dust exposure was lowered 76 pct when using the new pallet loading system. The second field evaluation showed only moderate dust reduction, but this was mainly attributed to an overriding problem associated with background dust and the cleanliness of the bags. From both the ergonomic and production standpoint, the system was well received by both the workforce and plant management.

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INTRODUCTION

The purpose of this study was to determine a cost-effective system to reduce worker dust exposure during the bag stacking process at mineral processing operations. This work dealt with the bag stacking process at a stationary loading position.

Both the National Industrial Sand Association and the Mine Safety and Health Administration stated a number of years ago that the bag loading and stacking operation was the area of primary concern with respect to dust. Since that time, the Bureau has been working on a number of projects to control dust in this area. The initial emphasis was on the bag loading process, which included studies such as the dual bag nozzle system (*1*),[3] the overhead air supply island, and the bag valve evaluation (*2*).

The Bureau has also worked on two separate studies dealing directly with the bag stacking process. The first study dealt with the process of directly loading pallets into enclosed railcars or trailer trucks, using a flexible snake conveyor system. This work was performed first as it presented the more serious health hazard because of higher bag stacker dust exposures. When dust is generated inside these vehicles during the pallet loading process, it has no means of exiting the vehicle or being diluted with fresh air; thus, dust concentrations increase to substantial levels. It was determined that dust reductions of between 65 and 95 pct could be achieved in and around the bag stacker by using a simple exhaust ventilation system (*3*).

The second study, described in this report, involves the Bureau-designed pallet loading dust control system for use at conventional pallet loading operations. Various automated systems have been introduced recently that are attractive from a dust control standpoint because they remove the worker from the dust source. However, these systems are very expensive, require much more room than a conventional bag stacking process; have high maintenance requirements, and have not been proven to be effective when dealing with highly abrasive material such as any silica-containing product.

Because the majority of mineral processing operations will not or can not use an automated pallet loading system, the intent of this work was to design a cost-effective dust control system with manual bag stacking. There were three major goals: (1) to reduce bag stacker dust exposure; (2) to ergonomically improve the bag stacker work process, and (3) to have no negative effect on production. All three goals have been achieved.

ACKNOWLEDGMENTS

The authors would like to thank Sean Gallagher, research physiologist, Pittsburgh (PA) Research Center, for his assistance in the ergonomic design of this system.

SYSTEM DESIGN

The following discusses how each of the three major goals impacted the system design.

DUST CONTROL

Reducing bag stacker dust exposure meant capturing the dust generated or released during pallet loading. The design implemented was a push-pull ventilation technique, recommended for tank ventilation by the American Conference of Governmental Industrial Hygienists (*4*). The tank ventilation design was to capture fumes coming from a batch process in open tanks. Since this application was concerned with capturing the dust over a 4- by 4-ft surface area, this ventilation technique was adapted.

The initial design for this application used a 250-cfm, low-volume, high-velocity slotted blower at one end of the pallet. The blower directs a stream of air across the top of the bags, which is captured by a 2,500-cfm exhaust system on the opposite side of the pallet. As the stream of air moves across the top of the bags, it entrains more air and dust that is carried into the exhaust system.

ERGONOMIC DESIGN

Ergonomics deals with the study of effective work action or posture for reduced stress and strain on workers, both physiologically and biomechanically. In bag stacking operations, the worker normally catches a bag from a conveyor belt at a height varying anywhere from waist to chest height. Ergonomically the optimum height to load

[3]Italic numbers in parentheses refer to items in the list of references at the end of this report.

a bag onto a pallet is at knuckle height, approximately 28 to 30 in above the ground.

With the conventional bag stacking cycle, the most undesirable lifting postures occur during the beginning and ending layers. Loading the first few layers of bags at the beginning of the pallet requires the stacker to bend down, so as not to allow the bag to drop and possibly break; loading the top few layers requires the stacker to lift the bags up and place them on the pallet. Therefore, these two cases produce much more physiological and biomechanical strain on the worker than when loading bags at knuckle height. Redesigning the loading task to knuckle height thereby reduces the risk of the worker experiencing a costly musculoskeletal injury.

The design of the pallet loading dust control system maintains the same, comfortable loading height throughout the entire pallet loading process. This loading height is manually controlled, using a hydraulic lift table.

PRODUCTIVITY

By improving the loading action of the worker ergonomically the fatigue level over the workday should be reduced, which would allow the bag stacker to maintain, or slightly improve, the production rate. In addition, there should be a long-term cost savings, because of the reduction in the number of back injuries, which account for the largest number of lost-time accidents in the mining industry (*5*). The amount of product being loaded by a stacker in some operations can exceed 50 tons each day. Any method to reduce the physiological strain on a worker loading this amount of product each day will be beneficial in the long run in terms of fewer back injuries and improved productivity.

Another possible benefit of the system is that three to four pallets can be loaded on the lift table at one time. After a completed pallet is removed by the fork lift with the conventional system, the stacker must obtain another pallet, then slide or carry it into place before the loading process can be repeated. With the new system, three to four pallets can be loaded on the hydraulic lift table at the same time. After the forklift removes a full pallet of bags, the next empty pallet is already in place, and the loading process can begin as soon as the hydraulic lift table is raised to the desired loading height.

The pallet loading dust control system is designed to work as follows: Three to four empty pallets are loaded onto the hydraulic lift table and the table is raised to the desired loading height. The bags are loaded by the stackers one layer at a time. The dust control ventilation system directs a high-velocity stream of air over the top of the bags being loaded. The airstream entrains any dust that is emitted or generated during the bag stacking process, and carries it into the exhaust system on the opposite side of the pallet. After each layer is completed, the pallet is hydraulically lowered the thickness of one bag, approximately 4 in. After the pallet is completely loaded, it is removed by a forklift and the cycle is repeated. The only critical feature of the ventilation system is that the height of the bags must remain beneath the blowing ventilation system.

LABORATORY TESTING

Laboratory testing was performed to evaluate and optimize the Bureau-designed pallet loading dust control system. All ductwork for the laboratory testing was fabricated from plywood, to allow quick modification of the components if necessary. A platform was built to allow the pallet to be lowered below the stacker's work level. For laboratory testing, a forklift was used in place of the hydraulic lift table to maintain the required pallet position.

A dust analysis was performed to compare the results obtained when loading pallets with the conventional system and with the new system. The bag stacker dust exposure was monitored continuously for both systems, using a RAM-1 dust monitor (*6*). The RAM-1 monitor is an instantaneous dust monitor that uses a light-scattering device to measure respirable dust concentrations when used with a 10-mm cyclone. This monitor is excellent for performing a comparative analysis of a worker's dust exposure. A 10-mm cyclone was attached to the bag stacker's lapel and connected to the RAM-1 dust monitor by flexible tubing; flexible tubing allowed the worker to stack bags with minimal interference. In addition to the dust analysis, smoke was used to provide a visual indication of the effectiveness of the pallet loading system (fig. 1).

The laboratory evaluation involved using three different workers to perform a number of runs. A run was composed of one cycle with the conventional system and one cycle with the Bureau-designed pallet loading system. A series of runs were performed using a slotted blowing system as recommended by American Conference of Governmental Industrial Hygienist (ACGIH) Industrial Ventilation Manual. After testing was completed, a National Institute of Occupational Safety and Health (NIOSH) study was reported that used a circular-type jet for a push-pull ventilation system (*7*). A circular air jet would have a number of advantages in this application, so a second laboratory evaluation was performed replacing the slotted blowing system with two circular 3-in air jets, using the same fan.

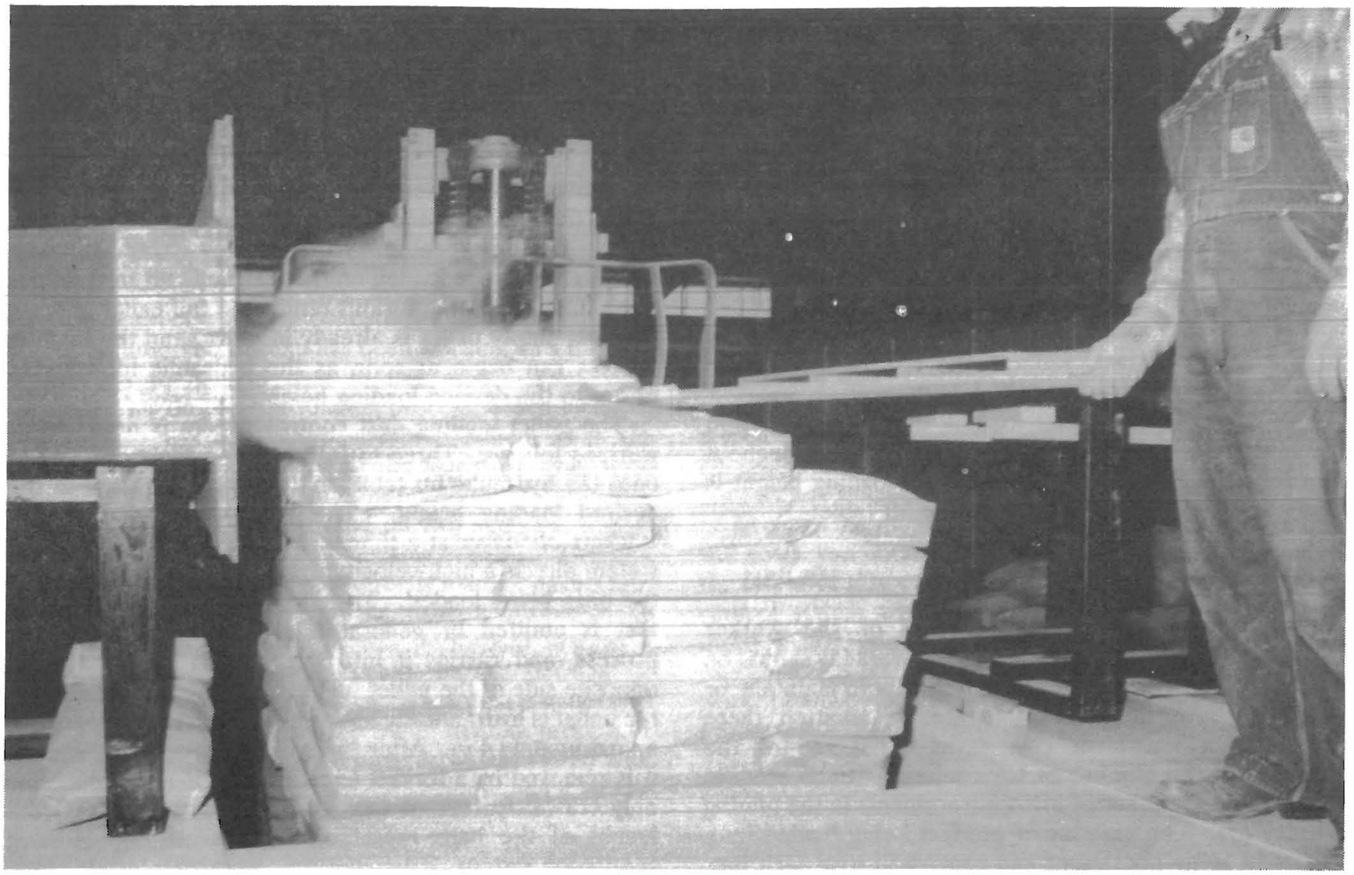

Figure 1.—Use of smoke to provide visual indication of system effectiveness.

LABORATORY RESULTS

The laboratory test results were used only for a comparative analysis of the conventional pallet loading cycle versus the loading cycle with the Bureau-designed system. Table 1 shows the results of the laboratory study for both types of blowing systems—slotted and circular air jets. The values listed in table 1 are the bag stacker's respirable dust exposure with the conventional system (off) versus with the Bureau-designed pallet loading system (on). Sixteen complete runs were performed on the system, eight with both the slotted and circular jet system.

The average reduction in worker dust exposure with the pallet loading dust control system was 69.1 pct. Figure 2*A* is a bar chart of the dust concentration for each run during the laboratory evaluation. Figure 2*B* shows the percent reduction achieved when using the pallet loading system. One noticeable effect is the change in results from phase 1 (slotted jets) to phase 2 (circular jets) of the study, which was separated by a 10-month time period. It is believed that the substantial changes in dust levels are attributable to the deterioration in the paper of the bags over this time period. The limestone dust on the outside of the bags from the various runs in phase 1 must have affected the paper quality over the 10-month time period. In phase 2, there was a continually increasing problem with bag failure or breakage; this is evident from the decline in the dust reductions achieved with the system. The average percent reduction in phase 1 was 79.68 pct versus only 58.47 pct in phase 2 with the circular air jets. Although this difference was identified in the dust analysis, it was not seen in the visual evaluation of the system using smoke; in fact, the circular jet system appeared slightly more effective at capturing most of the smoke.

Because of this slight visual difference with the circular air jets and the fact that the bag stacker would not interfere with the airflow over the bags as much with the jet system, the circular air jet system was chosen for the field evaluations of the system.

TABLE 1. - Bag stacker dust exposure during laboratory testing

(Total average reduction, 69.1 pct)

Run	Dust exposure, mg/m³ System off	Dust exposure, mg/m³ System on	Reduction, pct
1st LABORATORY EVALUATION: SLOTTED AIR JET			
1	4.04	2.14	47.03
2	5.93	1.06	82.12
3	2.93	1.26	57.00
4	6.06	.46	92.41
5	9.16	.48	94.76
6	5.83	.73	87.48
7	7.26	.69	90.50
8	7.12	.99	86.10
Av	NAp	NAp	79.68
2d LABORATORY EVALUATION: CIRCULAR AIR JET			
9	24.56	5.25	78.5
10	18.94	5.54	76.03
11	17.42	5.56	68.08
12	11.51	5.93	48.48
13	14.86	4.70	68.37
14	15.72	7.39	52.99
15	9.89	5.46	44.79
16	13.40	9.28	30.75
Av	NAp	NAp	58.47

NAp Not applicable.

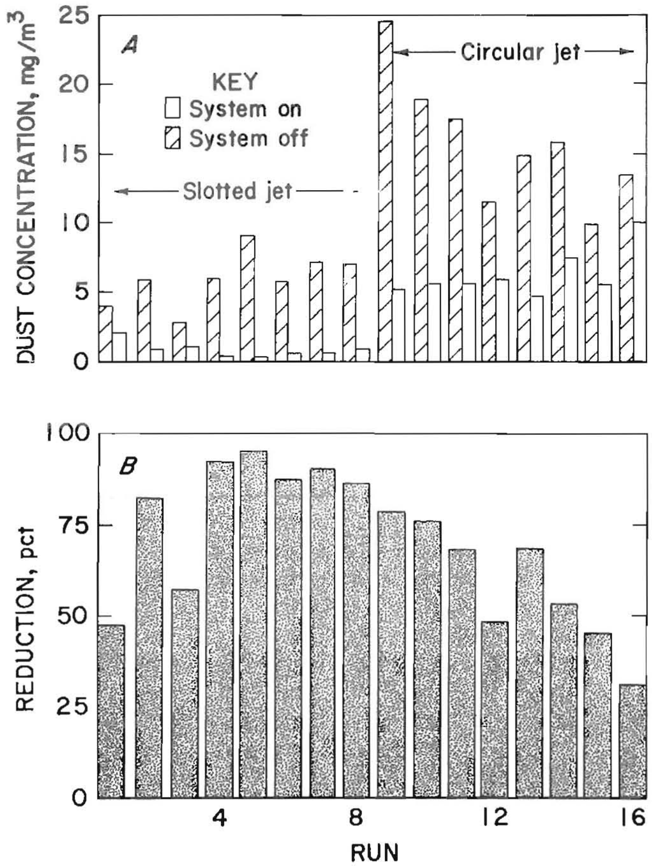

Figure 2.–Laboratory evaluation. ***A,*** **Dust concentration for each run;** ***B,*** **percent dust reduction for each run.**

FIELD TESTING

Two field evaluations were performed on the pallet loading dust control system to determine its effectiveness in the actual work environment. The first evaluation was performed at a silica sand operation and a somewhat modified system was used because the plant was already using a lift table to aid the worker in stacking. The second evaluation was performed at a high-production clay operation that required two bag stackers loading each pallet.

FIELD TEST SITE 1

In the first field evaluation, one worker performed the entire work process. The operator would load the bags using two fluidized air fill machines. When the bags where full, he would remove them from the fill machine and stack them onto a pallet located behind him. After a pallet was fully stacked, a forklift was used to transport it to the warehouse area. Since this was a silica sand operation, the operator allowable dust level was extremely low, with an approximate threshold limit value (TLV) of 0.2 mg/m^3.

Four RAM-1 dust monitors were positioned at various locations around the bag loading and stacking station. The primary interest was to determine the worker's exposure from a lapel monitoring setup that was identical to the laboratory study. Because the worker left the bag filling and stacking location after the completion of each pallet, the analysis was performed on a pallet-by-pallet basis. Two different workers were monitored at this operation during the evaluation.

The pallet loading dust control system used for this evaluation was similar to the system used in the laboratory study. The major difference was that the exhaust ventilation system was only drawing 1,800 to 2,000 cfm. Ideally, this exhaust volume should have been higher but was limited by the available air; both the blowing system and the exhaust system could be raised or lowered to match worker's preference on the loading height (fig. 3).

The effectiveness of the system was determined by comparing the dust levels obtained under normal operating conditions (system off) with those obtained with the pallet loading dust control system in operation. Table 2 shows the dust measurements at the four sample locations during the field evaluation. For the entire test period, worker dust exposure was reduced by 75.6 pct with the pallet loading dust control system based on the average system off concentration of 0.82 mg/m^3 versus 0.20 mg/m^3 with the system in operation.

For the most part, the stacker and blower results were fairly consistent. The main reason the exhaust monitor location was somewhat higher was because of a bag leakage problem occurring from a poor bag seal at the back of some bags. Dust was emitted out of the back of some bags during the filling process and then was pulled across the exhaust monitor. The background monitor was used to determine dust levels in the mill building so as to not allow an external source to influence or bias the results of the evaluation. For the most part, the background dust concentration remained fairly constant, around 0.1 mg/m^3. In a few cases, the concentration tended to rise, again mainly due to bag leakage.

Dust liberated from bag leakage was not totally captured by the pallet loading dust control system since it occurred at the bag filling station. Figure 4 is a bar graph of the bag stacker dust exposure, with and without the system in operation, while bagging 30-μm product. Dust

Figure 3.—Pallet loading dust control system at field site 1.

exposure was brought into the acceptable range through the use of the pallet loading dust control system.

FIELD TEST SITE 2

The second field evaluation was performed at a high-production clay operation that used two bag stackers who alternately loaded each bag onto the pallet. Since this product only contained a small percentage of silica, the allowable dust level TLV was much higher than for the silica sand operation. Two bag stackers were necessary at this operation because the high bag loading rate made it impossible for a single stacker to handle the entire pallet loading process. After a pallet was completed, a forklift operator would immediately remove the pallet, one of the stackers would carry or slide a new pallet into position, and the process was repeated. During positioning of a new pallet, the conveyor belt was shut down.

A dust evaluation system similar to that used at the first site was used, with primary emphasis on the dust exposure

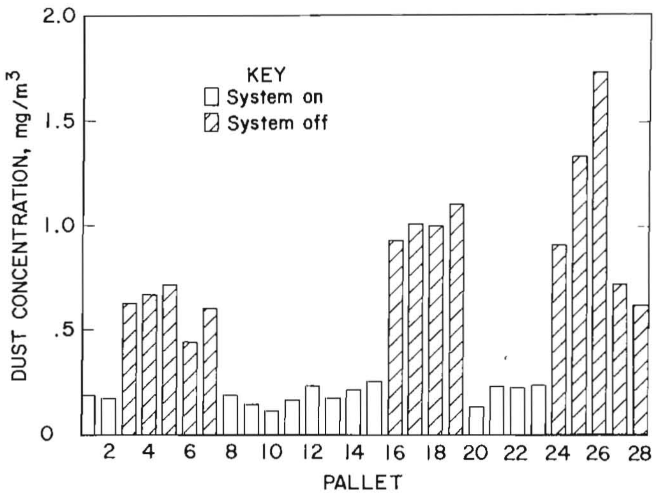

Figure 4.–Bag stacker dust exposure with and without pallet loading dust control system (field site 1).

TABLE 2. - Dust concentration at monitor locations for field site 1

Pallet	System on-off	Product size, µm	Dust monitoring locations, mg/m³ Stacker	Blower	Exhaust	Background
1	On	30	0.19	0.08	0.14	0.08
2	On	30	.18	.09	.27	.11
3	Off	30	.63	.34	.64	.08
4	Off	30	.67	.49	.58	.07
5	Off	30	.72	.50	.62	.07
6	Off	30	.45	.29	.66	.08
7	Off	30	.61	.46	.73	.07
8	On	30	.19	.07	.40	.06
9	On	30	.15	.08	.35	.29
10	On	30	.12	.06	.24	.07
11	On	30	.17	.10	.37	.08
12	On	10	.34	.13	.06	.08
13	On	10	.22	.07	.04	.06
14	On	10	.21	.11	.03	.06
15	Off	10	.61	.33	.09	.07
16	On	30	.24	.12	.30	.11
17	On	30	.18	.10	.28	.09
18	On	30	.22	.10	.34	.10
19	On	30	.26	.13	.35	.08
20	Off	30	.93	.55	.94	.07
21	Off	30	1.01	.47	1.11	.17
22	Off	30	1.00	.62	1.07	.17
23	Off	30	1.11	.60	1.28	.27
24	On	30	.14	.14	.68	.16
25	On	30	.24	.15	.72	.12
26	On	30	.23	.09	.60	.15
27	On	30	.24	.18	1.01	.17
28	Off	30	.91	.46	1.55	.31
29	Off	30	1.33	.69	1.45	.43
30	Off	30	1.73	.97	1.77	.37
31	Off	30	.72	.17	.49	.14
32	Off	30	.62	.22	.60	.27
33	On	10	.16	.05	.19	.09
34	On	10	.19	.09	.20	.14
35	Off	10	.35	.15	.29	.17
36	Off	10	.77	.21	.71	.11
37	Off	10	.78	.22	.57	.13
38	Off	10	.85	.21	1.04	.09
39	Off	10	.72	.32	.54	.05
40	On	10	.20	.08	.30	.07
41	On	10	.21	.07	.32	.06
42	On	10	.12	.04	.26	.04
43	Off	10	.77	.26	.53	.08

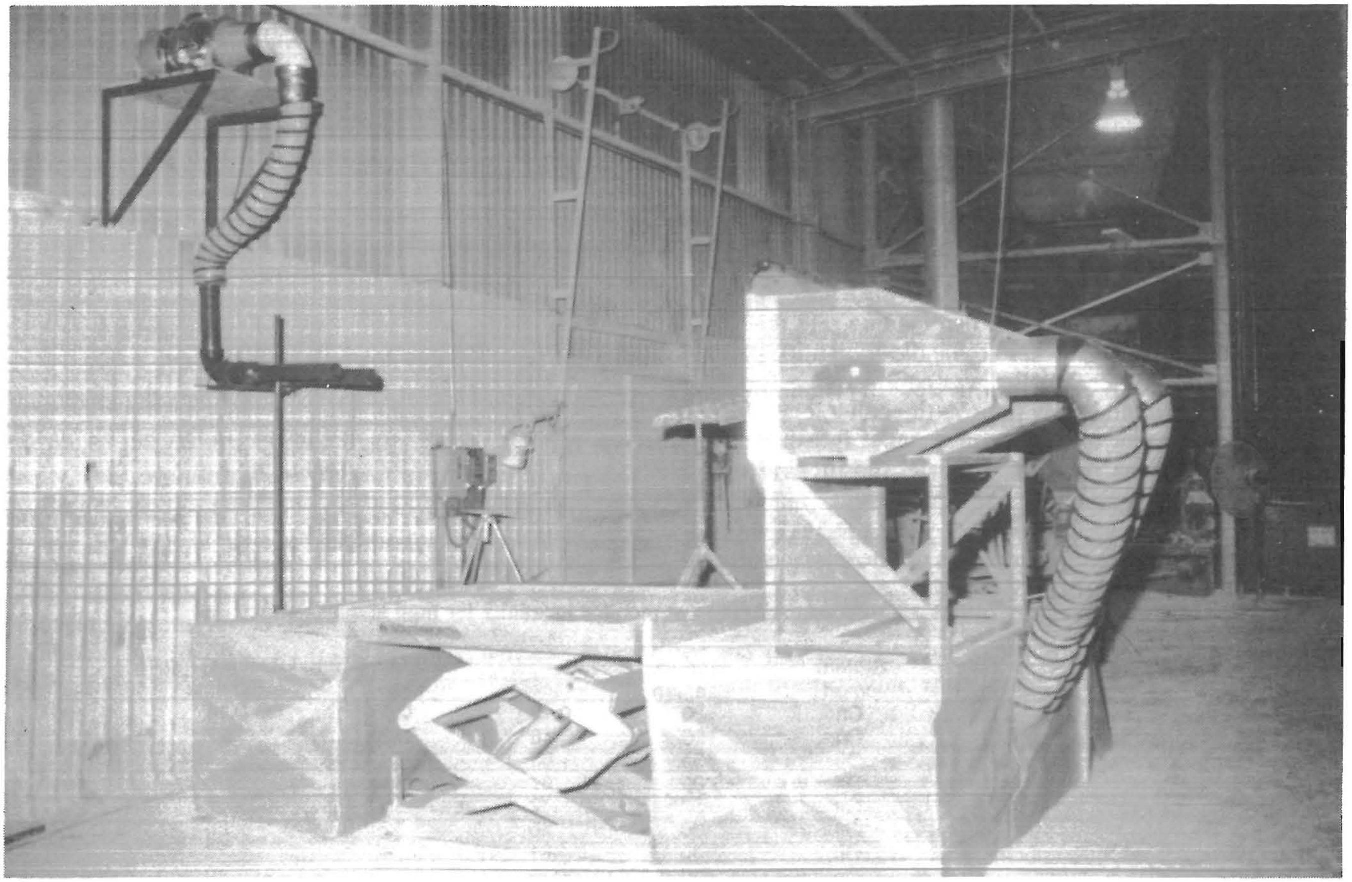

Figure 5.—Pallet loading dust control system at field site 2.

of the two bag stackers. Since each pallet was loaded so quickly at this operation, a run of bags was used as the comparative unit of measure, instead of using individual pallets. One run represented a series of four pallets.

The pallet loading dust control system was identical to the system used in the laboratory study. The exhaust ventilation was increased to 2,500 to 2,800 cfm. A platform was also fabricated that allowed the pallet of bags to go below the work level in order to load the top few layers of bags at the required height. The system again allowed some adjustment to the operator's preference of loading height (fig. 5).

Table 3 shows the dust concentrations at the four monitor locations for the second field evaluation. From a dust control standpoint, a major factor significantly affecting the evaluation was the amount of background dust at various times throughout the workday. The main contributor to this background dust was railcar bulk loading outside of the mill building, causing a measurable increase in dust levels inside the building. Figure 6 shows the amount of dust generated during bulk loading.

Because of these high background dust levels, it was necessary to normalize the results by subtracting these background dust levels. Table 4 shows the bag stackers normalized dust exposure that more closely represents the dust from the bag stacking process. Using these normalized values, the average reduction in bag stacker dust exposure was 30.5 pct for the entire week of testing.

In addition, the plant employed a number of different dust control techniques that effectively removed dust from the bags. These included the Bureau-developed dual bag nozzle system and recommended bag hood enclosure, and a dust control system during the bag flattening process. Because of these control techniques, the bags of product being loaded onto pallets by the stackers were much cleaner, so that dust reductions were lower with the new system. A system modification was made after the first day of testing to bring the blower and exhaust system 8 in closer (4 in on each side). After this modification, runs 7 through 33, the bag stacker dust exposure averaged a 33.0-pct reduction.

TABLE 3. - Dust concentration at monitor locations for field site 2

Run	System on-off	Grind size, µm	Dust monitoring locations, mg/m³ Stacker 1	Stacker 2	Platform	Background
1	On	600	1.09	0.86	0.83	0.54
2	Off	600	.95	.82	.52	.26
3	Off	240	1.42	1.16	.86	.53
4	On	240	1.29	1.16	1.15	.58
5	Off	240	2.46	1.97	1.45	.60
6	On	240	2.11	1.53	.86	.59
7	On	240	1.92	1.56	1.09	1.16
8	Off	240	2.43	1.86	1.28	1.09
9	On	240	2.49	2.19	1.51	1.61
10	Off	240	3.13	2.38	1.75	1.84
11	On	240	3.13	2.35	2.18	2.31
12	Off	240	2.66	1.97	1.93	1.71
13	On	240	2.93	1.51	1.97	1.98
14	Off	240	2.09	1.84	1.16	1.25
15	On	240	2.01	1.57	1.31	1.06
16	Off	240	2.03	1.66	1.08	.99
17	On	240	1.92	1.80	1.21	1.39
18	On	240	1.12	1.00	.70	.38
19	Off	240	1.61	1.31	.83	.31
20	On	240	1.13	1.05	1.09	.32
21	Off	240	1.60	1.59	1.26	.33
22	Off	240	1.83	1.72	.90	.50
23	On	240	1.41	1.21	.79	.41
24	Off	400	1.78	1.12	.70	.78
25	On	400	1.75	1.38	1.01	1.09
26	Off	400	1.76	1.37	.87	.73
27	Off	400	1.22	1.13	.68	.60
28	On	400	1.48	1.04	.89	.69
29	Off	400	1.51	1.29	.79	.56
30	Off	240	1.63	1.09	.82	.59
31	On	240	1.38	1.11	.96	.64
32	Off	240	1.65	1.34	1.01	.75
33	On	240	1.22	.99	.84	.76

Figure 6.-Background dust generated from bulk railcar loading at field site 2.

TABLE 4. - Normalized dust concentrations for bag stackers for field site 2

Run	System on-off	Grind size, µm	Normalized concentration, mg/m³ Stacker 1	Stacker 2
1	On	600	0.55	0.32
2	Off	600	.70	.57
3	Off	240	.90	.64
4	On	240	.71	.58
5	Off	240	1.86	1.37
6	On	240	1.52	.94
7	On	240	.77	.41
8	Off	240	1.34	.77
9	On	240	.89	.59
10	Off	240	1.30	.55
11	On	240	.82	.04
12	Off	240	.95	.26
13	On	240	.95	([1])
14	Off	240	.85	.60
15	On	240	.95	.51
16	Off	240	1.05	.66
17	On	240	.54	.42
18	On	240	.74	.62
19	Off	240	1.30	1.00
20	On	240	.81	.73
21	Off	240	1.28	1.27
22	Off	240	1.34	1.23
23	On	240	1.00	.80
24	Off	400	1.00	.34
25	On	400	.66	.29
26	Off	400	1.04	.65
27	Off	400	.63	.54
28	On	400	.80	.36
29	Off	400	.96	.74
30	Off	240	1.04	.50
31	On	240	.75	.48
32	Off	240	.90	.59
33	On	240	.47	.24

[1]Information lost because of equipment malfunction.

DISCUSSION

As stated earlier, there were three goals to the research effort. The first was to reduce the dust exposure of the bag stacker. This was achieved in the laboratory study, as well as the first field evaluation, with average dust reductions to the bag stackers of 69 and 76 pct, respectively. The average reduction of 33 pct at the second field evaluation site was disappointing, but this resulted from the very clean condition of the bags coming off of the conveyor belt.

The second goal of this program was to ergonomically improve the bag stacking process. Although no physiological stress studies were performed with and without the system in operation, all workers commented on the reduced effort and ease of loading bags with the new system. Figure 7 shows the height that the bag stacker had to lift the bags to load the top layer for a number of pallets at the second evaluation site. Lifting 50-lb bags of product to this height is very fatiguing. With the pallet loading system in operation, the bag stacker never has to bend down to load the first few layers of bags or stretch to lift bags for the top few layers, since the loading height remains constant throughout the entire pallet loading process.

The third goal of this research effort was to avoid production losses with the system. This was also accomplished, although it was not possible to perform an actual time study at either field evaluation site because of fluctuations with bag fill rates. Fill rate depends heavily on the amount of material in the fill hopper; the higher the level of product, the faster the bags fill. There is no way to maintain a certain material level in the hopper or to measure the product height, making it impossible to accurately measure production rates. However, the new system should slightly increase production from two standpoints: First, the pallet loading system is physiologically easier for the worker, thus reducing fatigue over the workday and allowing the worker to maintain a steadier pace. Second, as observed at the second field evaluation site, was the ability to reduce downtime between pallets. As the forklift immediately removes a full pallet upon completion, one stacker manually raises the lift table to the loading height while the other stacker is ready to load the next bag without turning the conveyor system off. The conveyor would only have to be shut down after every four pallets.

The pallet loading dust control system has been proven to be a field worthy and flexible system. Once it is installed, there is very little that needs to be maintained. The fan for the blowing system and the hydraulic lift table should be greased periodically. The exhaust system would

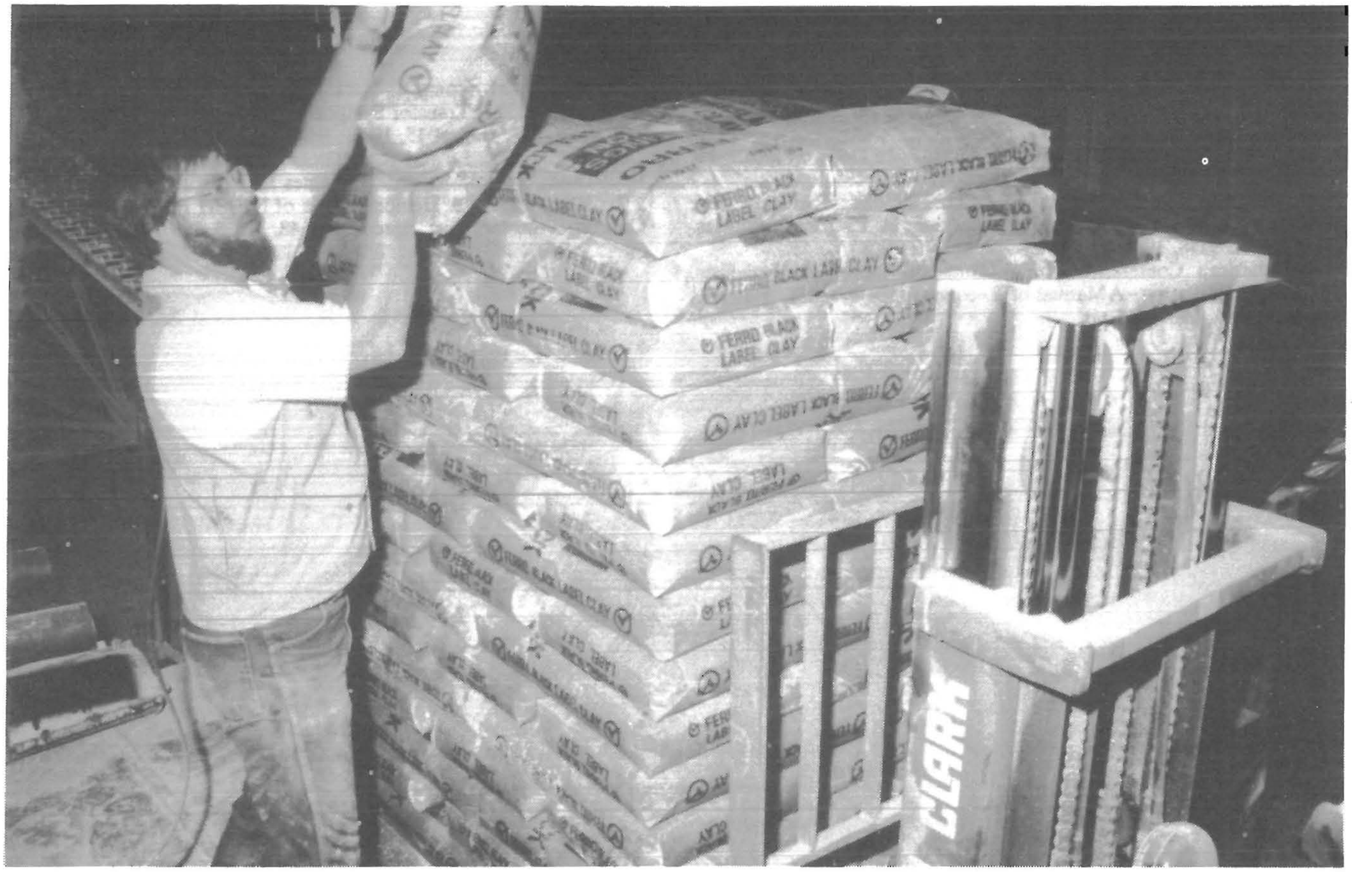

Figure 7.–Lift height required by bag stackers at field site 2 with conventional system.

most likely be ducted into a baghouse eliminating the need for a fan.

The system is very flexible in its operation from a performance standpoint. As long as the bag level is kept below the level of the air jets, the system works well. The system maintains its effectiveness even if the bag level is 10 to 12 in below the air jets, which allows loading two or three bag layers before repositioning the pallet level. Also, the airflow on the system is not strong enough to make the bag stackers uncomfortable.

CONCLUSIONS

The Bureau has developed and tested a pallet loading dust control system for bag stacking at mineral processing facilities that uses push-pull ventilation to capture the dust generated during the bag stacking process. A low-volume, high-velocity stream of air is directed over the top of the pallet, entraining any dust generated during the bag stacking process and carrying it into an exhaust ventilation system on the opposite side of the pallet. The loading height is kept constant during the entire pallet loading cycle through the use of a hydraulic lift table. This maintains the effectiveness of the dust control ventilation system while making it ergonomically easier for the bag stackers to load the bags onto pallets.

This pallet loading dust control system is effective in three areas. First, it reduces the bag stacker dust exposure. Second, it ergonomically reduces the physiological effort and biomechanical stress experienced during bag stacking. Third, it does not increase the pallet loading time and might, in fact, increase production slightly because of less downtime between pallets and less worker fatigue. It is a simple, flexible, cost-effective system that has been well received by labor and plant management during field evaluation.

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