11^{th} U.S./North American Mine Ventilation Symposium 2006 – Mutmansky & Ramani (eds)
© 2006 Taylor & Francis Group, London, ISBN 0-415-40148-8

Lowering respirable dust at an iron ore concentrator plant through improved ventilation practices

A.B. Cecala, J.A. Zimmer, J.F. Colinet & R.J. Timko
National Institute for Occupational Safety and Health, Pittsburgh Research Laboratory, Pittsburgh, PA, USA

ABSTRACT: A cooperative research effort was established between the Tilden Mining Company LC, the United Steelworkers of America, and the National Institute for Occupational Safety and Health to lower respirable dust levels in an iron ore grinding and concentrator plant. This cooperative effort involved three field studies to evaluate different techniques to lower respirable dust levels. The greatest impact on lowering respirable dust concentrations throughout this facility was achieved through ventilation changes. The most significant improvement was realized by changing the ventilation profile throughout the entire facility. The ventilation to this grinding and concentrator facility was provided by approximately 40 roof fans operating in either the intake or exhaust mode. The operation of these fans was significantly changed in an attempt to provide more of a directional flow pattern throughout the facility, as well as to more closely balance the intake and exhaust air volume. This change accounted for a 31 pct reduction in respirable dust levels in the primary grinding area of the mill. Another successful modification was to improve the sealing of a reclaim tunnel to the outside and by barricading the access point from the reclaim tunnel to the concentrator plant. This minimized the dust liberated in the conveyor tunnels from traveling through the reclaim tunnel and into the plant. These two modifications illustrate the impact that improvements in ventilation can have on lowering respirable dust concentrations in iron ore processing facilities.

1 INTRODUCTION

In August 2000, the United Steelworkers of America held a health and safety workshop in Eveleth, Minnesota to discuss methods and techniques to improve working conditions for its membership in the iron ore mines in Minnesota and Michigan. For this workshop, the National Institute for Occupational Safety and Health (NIOSH) was requested to provide a 90-minute presentation on dust control research applicable to the iron ore industry. Shortly after this workshop, NIOSH was contacted by the Tilden Mining Company LC who stated their interest in working with NIOSH and the United Steelworkers of America union membership at their operation to lower respirable dust concentrations in the grinding and concentrator mill. Shortly after receiving this request, a trip was scheduled (April 2001) for two individuals from NIOSH's Respiratory Hazards Control Branch to visit the Tilden operation in Ishpeming, Michigan. The first part of this visit was a meeting with all three parties to discuss a number of potential dust control areas of interest. After this meeting, NIOSH was given a tour of the entire facility with special emphasis given to the grinding and concentrator mill. Shortly after this visit, NIOSH submitted a proposal for a cooperative research effort to reduce respirable dust levels in the grinding and concentrator facility to the Tilden Mining Company and the United Steelworkers of America. A short time later, NIOSH received notification that both parties were in agreement and wanted to proceed on this cooperative research effort.

This cooperative effort has been composed of three different studies at the Tilden grinding and concentrator facility: March 11–13, 2002, March 5–7, 2003, and March 9–11, 2004. The first study was mainly a baseline analysis to determine dust levels throughout this huge facility and determine research areas that could have the most significant impact on lowering dust. The next two visits were directed towards specific areas of dust control technology.

All three studies were performed in March for a number of reasons. First, the Tilden grinding and concentrator mill would switch from producing magnetite to hematite throughout the course of the year. Hematite is a dustier product and was typically produced from November through March. All parties agreed that this research should be performed during the production of hematite in an effort to have the greatest impact on lowering respirable dust concentrations. Another factor in the timing of this research involved traveling in the winter months. The Tilden operation is in the upper peninsula of Michigan, where winters can be, and usually are very severe. In March, winter conditions usually begin to ease somewhat, facilitating personnel going onto the roof of the structure to check on fan operation. The last factor for performing this research during the winter months is because the facility is typically closed to limit the inflow of cold air into the structure.

The grinding and concentrator mill at the Tilden operation was an 87,300 m^2 (940,000 ft^2) structure with an internal air volume of 1,274,000 m^3 (45,000,000 ft^3). The ventilation provided to this building was through a network of roof fans that can be used, for the most part, in either an intake or exhaust ventilation mode. In addition to the numerous roof-powered fans, each of two replacement air systems supplied 4250 m^3/min (150,000 cfm) of heated intake air in the basement of the structure, one on the eastern and the other on the western side of the structure. With this setup, the building had an exhaust capacity of approximately 121,776 m^3/min (4,300,000 cfm) and an intake air capacity of 23,500 m^3/min (830,000 cfm) based upon the rated capacity of the fans. Again, 8500 m^3/min (300,000 cfm) of this air was from the intake air heaters. The roof-mounted fans are the only source of powered exhaust ventilation to the facility, although there may have been some natural ventilation as the warm air within the structure rises and escapes through cracks or openings in the exterior walls or the roof. The amount of natural ventilation was minimal in comparison to the amount of air exhausted through the roof fans.

The ventilation setup at this facility changed somewhat over the course of the year based on outside air temperatures. Typically, the air exhausted from the structure was significantly less during the winter months, with the goal being to provide enough ventilation to remove contaminants while trying to maintain an adequate temperature within the structure. During the summer months, the facility is more open to the outside air and the exhaust air from the roof fans is maximized to remove the heat generated from all the electrical motors and other processes within the facility.

One last area to consider for this research effort is the location of various ore processes within the structure. Because some of the processes are more inherently dusty, certain areas of the grinding and concentrator facility typically have higher dust levels. Figure 1 shows an overview of the major processes in this facility. The raw ore mined at the operation is taken to a primary crusher where it is sized to less than 25.4 cm (10 inches). The ore is then conveyed to a covered storage building that is located along the entire northern portion of the grinding and concentrator

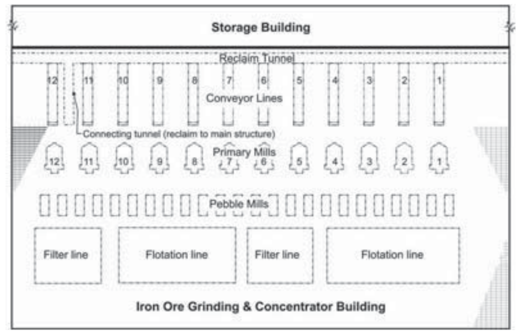


Figure 1. Location of major processes in grinding and concentrator building.

facility. When the ore is ready to be processed, it flows by gravity into the facility onto one of 12 conveyors lines which brings the ore up a slope that feeds a primary grinding mill. Each of these 12 primary grinding mills then feed 2 pebble mills that further reduce the size of the material. After the ore exits the pebble mills and has been properly sized, it enters thickener tanks, then flotation tanks, and then back into concentrator thickener tanks. From this point, it enters concentrate slurry tanks and is filtered. The ore exits the structure and is delivered to the palletizing building.

The 12 conveyor lines and the primary grinding mills are located in the northern portion of the structure, which encompasses approximately half of the total area of the building. This is also the dustiest area of the structure and Tilden management requires that all personnel wear personal protective respiratory equipment when in this portion of the facility. The 24 pebble mills encompass approximately a quarter of the facility. The last quarter is made up of the concentrator, slurry, thickener tanks, and filtering area. The southern portion of the building is much less dusty and does not require work personnel to wear respiratory protection.

2 SAMPLING INSTRUMENTATION

The following section describes some of the instrumentation used in this cooperative research effort. Although many types of monitors and instruments were used, this discussion will be limited to the dust monitoring and air flow instruments used in the two ventilation research efforts discussed in this report. Gravimetric dust sampling packages and PDR instantaneous dust sampling devices will be discussed, followed by the two types of instruments used for measuring air velocity.

Gravimetric dust sampling packages consisted of two sampling units, each containing a sampling pump, flexible tygon tubing, a respirable dust classifier, and a filter. All dust samples were collected with the

10-mm Dorr-Oliver cyclone, which classifies the respirable portion of dust, (usually considered having an aerodynamic diameter of 10 microns or less). Each gravimetric pump was calibrated to a flow rate of 1.7 liters/min, (the Mine Safety and Health Administration's (MSHA) required flow rate for the metal/nonmetal industry). The respirable dust classified by the 10-mm cyclone was deposited on a 37-mm dust filter cassette. These filters were pre- and post-weighed to the nearest microgram on a microbalance at the Pittsburgh Research Laboratory (PRL) and the results of each sampling unit's filters were averaged together to determine an average respirable dust mass. From this mass value, the average respirable dust concentration over the sampling period was mathematically derived.

The instantaneous monitors used for this testing were the Personal Data RAM (PDR) from MIE, Inc. of Bedford MA. This is a real-time aerosol sampler that measures the respirable dust concentration based upon the light scattering of particles drawn through an internal sensing chamber. The respirable dust levels obtained by light-scattering were recorded on an internal data logger and then downloaded to a laptop computer at the end of each sampling shift. After the dust traveled through the PDR, it was deposited on a filter cassette, identical to that of a gravimetric sampler. A new filter cassette was used for each shift of testing and was analyzed with the other gravimetric samples upon returning to PRL. For each sampling location, the PDR dust value was divided into the average gravimetric concentration to determine a correction factor, which was then applied to all the measurements taken with the corresponding PDR for that shift. This allowed the instantaneous respirable dust concentrations to be corrected to equivalent measurements taken using the gravimetric method. All PDR instrument values shown in this report have been corrected in this manner. Using both of these types of respirable dust monitoring equipment provided a good profile of average dust concentrations throughout the sampling period, as well as variations and changes in respirable dust concentrations relative to time throughout the workday.

In addition to the respirable dust measurements, airflow measurements were taken using a Solent Velometer from Gill Instruments Limited of Hampshire, England to evaluate the airflow at different locations throughout the grinding and concentrator mill building. This velometer is an ultrasonic anemometer that operates by transmitting an ultrasonic pulse along the wind path and measuring the time taken to reach the receiver. In essence, the faster the wind speed, the faster the pulse reaches the receiver. The velometer was held stationary and a 10-sec sample period was started. At the end of the 10 seconds, the instrument provided average, maximum and minimum air velocities for that specific time period.

In addition, velocity measurements were also taken with a vane-anemometer from Davis Instruments of Baltimore, MD. The Davis anemometer was a 10 cm (4-in) diameter, eight-blade instrument that can measure air velocities from 0.15–25 m/s (30 to 5000 ft/min). It contains a balanced vane wheel that rotates in response to airflow. Rotations are mechanically transmitted to an indicator through a clock-like movement.

3 TESTING AND RESULTS

In this cooperative research effort, a number of different areas were investigated in an effort to lower respirable dust concentrations at the Tilden iron ore grinding and concentrator facility. It should be noted that, although the goal was to lower respirable dust concentrations throughout the entire facility, the main priority was the primary grinding area. In this report, we will describe the two most successful efforts, both of which were directly tied to ventilation changes. The first area to be presented is the impact that lowering the amount of ventilation flowing through the reclaim tunnel had on lowering respirable dust levels in the western portion of the structure. The second area is the efforts to improve the ventilating airflow pattern throughout the entire grinding and concentrator mill using the roof-mounted fans in a more direct and balanced flow pattern and the impact that this had on respirable dust levels, specifically in the primary grinding mill area.

3.1 *Improving ventilation and dust in reclaim tunnel*

When performing our baseline testing during the first evaluation in March 2002, it was determined that dust levels increased from the eastern to the western portion of the reclaim tunnel. The reclaim tunnel is a 2.1 m (7 ft) wide by 2.3 m (7½ ft) high opening that runs the entire length of the facility along the northern portion of the structure. The function of the reclaim tunnel is to provide access for workers and equipment to the 12 conveyor lines. Workers are not normally in the reclaim tunnel unless they need to access one of the discharge chutes or conveyors, which moves iron ore from the storage area to one of the 12 primary grinding mills. During a walk-through, it appeared that there was a substantial amount of air moving through this tunnel and there appeared to be no practical reason for this amount of ventilation.

To focus on the reclaim tunnel, a test sequence was performed on the daylight shift of March 6, 2002. Eleven different dust sampling locations provided a profile of respirable dust concentrations along the tunnel, as well as in some of the conveyor slopes. These monitors were started over a one-and-a-half hour time

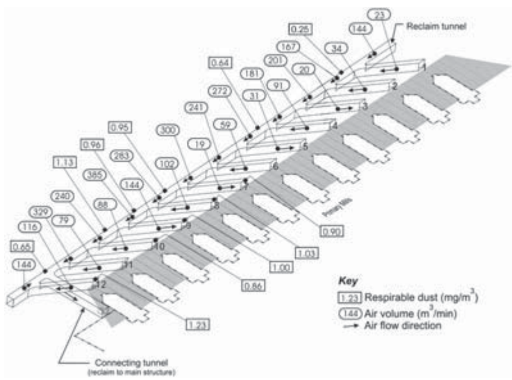


Figure 2. Respirable dust and airflow measurements during baseline testing in 2002.

period and sampled for between five and six hours. Six of these samples were located along the reclaim tunnel, with a seventh sample location at the midpoint of a lower north-south tunnel that connected the reclaim tunnel to the main building basement. This connecting tunnel was located between primary mills 10 and 11 and connected the reclaim tunnel to the primary grinding and concentrator mill about 9 m (30 ft) below the main working elevation. The remaining four sampling locations were at conveyor transfer locations in tunnels 6, 7, 9, and 10. These 11 dust sampling locations provided a good overview of respirable dust concentrations for the tunnel. In addition, velocity measurements were also taken along the entire length of the reclaim tunnel, in the connecting tunnel to the basement of the grinding and concentrator building, and in each of the 12 conveyor slope tunnels.

The dust concentrations and ventilation measurements taken are shown in Figure 2. The values listed in this figure show a correlation between respirable dust concentrations and airflow measurements. From a dust control standpoint, respirable dust levels increased as one moved from the eastern to the western side of the reclaim tunnel. Once the airflow traveled a short distance past tunnel 11, it would make a 90 degree turn and flow down the connecting tunnel to the main structure. As seen, the respirable dust concentration in this connecting tunnel was lower than the eastern dust values (tunnels 1–11) along the reclaim tunnel because the dust was being diluted with an additional 144 m^3/min (5,100 cfm) of ventilating airflow that was coming from conveyor tunnel 12 and was traveling in the reclaim tunnel from west to east. Although no dust measurements were taken, it is assumed that the respirable dust concentration of this air was very low. When this airflow was combined with the airflow traveling from east to west, it diluted the respirable dust concentration down to 0.65 mg/m^3. The velocity measurements in the reclaim tunnel show the magnitude of airflow in this tunnel. The airflow direction in the conveyor slopes varied with some air moving up the slope towards the grinding and concentrator building and others with air moving down towards the reclaim tunnel. For those tunnels that were ventilating downwards, they were introducing respirable dust generated during conveying and at transfer points into the reclaim tunnel. As this air moved from east to west in the tunnel, each additional conveyor slope would add additional dust to the airstream.

After analyzing the data from this test, researchers concluded that the 620 m^3/min (21,900 cfm) of air being discharged into the basement of the structure from the connecting tunnel needed to be reduced. This volume of air had a respirable dust concentration of 0.65 mg/m^3, which was introducing a significant quantity of dust into the grinding and concentrator mill building. This volume of dusty air caused respirable dust concentrations to be higher in the basement and first floor of the structure in the western portion of the building, as compared to the center or right portions of the structure.

A factor in the amount of air moving through the reclaim tunnel was that the seal at the eastern end of the reclaim tunnel was badly damaged and was allowing a significant quantity of air into the tunnel. Air measurements at this location indicated that approximately 144 m^3/min (5,100 cfm) of air was coming into the reclaim tunnel from this damaged seal.

The other area of concern was the amount of air flowing from the reclaim tunnel into the grinding and concentrator structure basement from the connecting tunnel. Through discussions with all the cooperating parties in this research effort, it was decided to replace the damaged seal at the eastern end of the tunnel and to install a seal where the connecting tunnel accessed the main structure.

When returning for the 2003 study, NIOSH was pleased with the quality of the seals installed at both locations by Tilden personnel, shown in Figure 3a,b. The first test performed during this study was to repeat the evaluation of the reclaim tunnel area. Identical respirable dust sampling and airflow measurement locations were used as performed in the previous study.

The results of this test can be seen in Figure 4. As shown, dust levels constantly increased when moving from the east to west in the reclaim tunnel. For a number of areas, one could visually see dust flowing down the conveyor slope and into the reclaim tunnel. Average respirable dust levels increased from 0.21 mg/m^3 between tunnels 2 and 3 to 2.44 mg/m^3 between tunnels 10 and 11. Respirable dust levels in the lower connecting tunnel averaged a concentration of 1.27 mg/m^3 over the entire sampling period.

When comparing the results from pre to post-seal conditions, there are a number of areas that standout. First, during pre-seal testing, there was 144 m^3/min

Figure 3a. Seal replaced at eastern end of reclaim tunnel to access outside.

Figure 3b. Seal installed where connecting tunnel accesses main structure in basement of facility.

(5100 cfm) of air flowing from the door at the eastern most portion of the reclaim tunnel; this was reduced by 76 pct to a level of 34 m^3/min (1200 cfm) under post- seal conditions. In addition, there was a reversal in the airflow direction in a number of the sloped conveyor tunnels. For the lower numbered tunnels, the air quantity moving up or down the tunnel during post-seal was substantially lower than during pre-seal conditions. Conveyor tunnel 9 showed a significant increase in airflow quantity traveling up the tunnel with 215 m^3/min (7600 cfm) for post-seal, as compared to 144 m^3/min (5100 cfm) for pre-seal. The effectiveness of the barricade on the lower level connecting tunnel is also verified by these values. The airflow measured in the connecting tunnel during post-seal was 22.7 m^3/min (800 cfm), which is a 96 pct reduction from the 620 m^3/min (21,900 cfm) measured during pre-seal conditions.

When considering the dust values, it may appear that improving the seal in the reclaim tunnel was counter productive because respirable dust concentrations

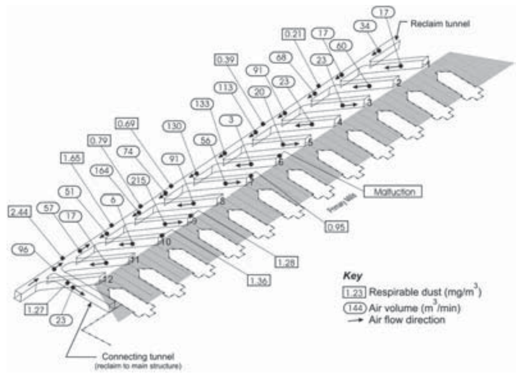


Figure 4. Respirable dust and airflow measurements during 2003 testing after installation of seals.

increased at some locations. This increase was first noticed at the midpoint for mills 9 and 10 and remained elevated at the next two sample locations. The dust liberated in the various conveyor slope areas and drawn into the reclaim tunnel was diluted by a much lower quality of air, and thus, the reason for the higher dust concentration at the western portions. To consider the true impact of the seals on lowering respirable dust flowing into the grinding and concentrator building from the reclaim tunnel, both the airflow and the respirable dust concentrations must be considered. For pre-seal test conditions in 2002, there was 620 m^3/min (21,900 cfm) of air traveling into the main structure at a respirable dust concentration of 0.65 mg/m^3. Through a simple calculation, it was determined that 24,188 mg of respirable dust was being delivered into the main building every hour under pre-seal conditions. And although the respirable dust levels are higher under post-seal conditions at a level of 1.27 mg/m^3, when one considers this value with the reduction in airflow, only 1729 mg of respirable dust is being delivered into the main building every hour, a 93 pct reduction over pre-seal conditions.

The most significant benefit from the installation of seals and minimizing the airflow through the reclaim tunnel is the significant reduction in the amount of respirable dust being introduced into the western portion of the building. In the pre-seal testing, there was a 67 pct increase in respirable dust concentrations at primary mill 12 (0.67 mg/m^3) on the western side of the building as compared to respirable dust levels at mill 1 (0.44 mg/m^3) on the eastern side. When the exact study was performed again with post-seal conditions, both dust measurements were almost identical: 0.84 mg/m^3 at mill 12 and 0.87 mg/m^3 at mill 1. Although the respirable dust concentrations at both locations went up, this is a relative value based on the amount of production and ore being processed at any given time period. Respirable dust levels being identical on the eastern

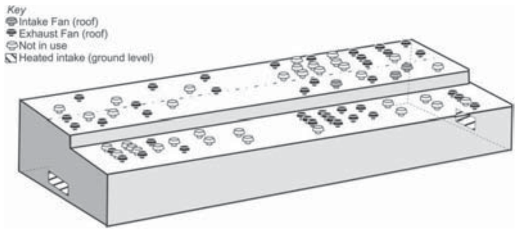


Figure 5. Baseline or normal ventilation setup.

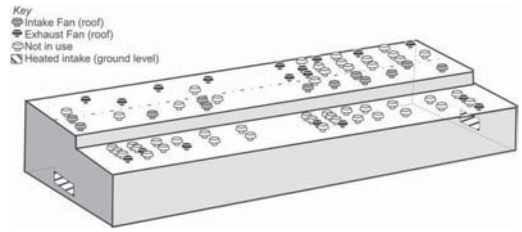


Figure 6. Ventilation setup #2.

and western side of the structure indicates the impact that the seals had on minimizing the amount of airflow traveling through the reclaim tunnel.

3.2 *Entire structure ventilation*

During the testing performed during 2003, an entire-structure ventilation change was performed which indicated promising results. This led to a more in-depth study performed during 2004 which involved changing the quantity of air that entered and was exhausted from the structure. During the first day of testing, the operation's normal ventilation setup was evaluated. Figure 5 shows a summary of this ventilation setup with the exhaust and intake fans differentiated by shading of the fan symbol. To evaluate this original ventilation design, the structure was broken down into three distinct areas: primary grinding (northern-most portion), secondary grinding with pebble mills, and filtering and flotation (southern-most portion). Respirable dust samplers were located in these three areas, with the greatest focus being on the primary grinding mills. This original ventilation setup included twelve exhaust fans in the primary grinding area, eight exhaust fans and three intake fans in the secondary grinding area, and nineteen exhaust fans in the filter and flotation area. The only other mechanical ventilation provided was from two intake heater fans located at the base of the facility, one located on the east and the other on the west side of the building. The volume of air being exhausted from the structure was 54,670 m^3/min (1,930,500 cfm), as compared to 17,000 m^3/min (600,000 cfm) being brought into the structure. These ventilation air volumes were calculated based upon the fan quantities provided by the facility and the assumption that all the fans were operating at their rated output. The two intake heater fans accounted for 8,500 m^3/min (300,000 cfm), or 50 pct of the total intake airflow. Dust sampling under this ventilation setup was performed for approximately 20 hours of testing.

The imbalance between the intake and exhaust air volumes with this ventilation setup was substantial; therefore it was decided to modify the ventilation to a more balanced design. It should to be noted that although the goal was to lower respirable dust concentrations throughout the entire facility, the main priority was to lower respirable dust concentrations in the primary grinding area. Dust levels in the primary grinding area were higher than in the other areas because of the amount of dust liberated from the numerous conveyor lines feeding the primary grinding mills, as well as the amount of dust liberated from the mills themselves.

To focus on this area, a ventilation change was initiated as shown in Figure 6. The two intake heater fans continued to bring a significant portion of intake air into the facility. For this modified design, there were eleven exhaust fans operating in the primary grinding area, twelve intake fans in the secondary grinding area, and eight exhaust fans operating in the filtering and flotation area. The volume of air being exhausted from the structure was approximately 26,600 m^3/min (940,500 cfm), with approximately 29,600 m^3/min (1,045,000 cfm) brought into the structure through the roof intake fans and two heater fans. This ventilation design was again tested for approximately 20 hours.

During this phase of testing, a smoke flare was released into one of the intake fans over the pebble mill. Since properly operating intake fans should move an air parcel 10 fan diameters before being reduced to 10 pct of the fan's air velocity, the roof-mounted fans should introduce a parcel of air into the lower parts of the building (Industrial Ventilation, 2001). These roof-mounted fans are all 1.2 m (4 ft) in diameter and should introduce a parcel of air at least 12.2 to 15.2 m (40 to 50 ft) into the structure. Since this testing was performed during the winter months, introducing cold outside air into the structure should also assist the air parcel's ability to flow down into the lower levels of the structure. From visual observations during this smoke flare release, it appeared that the intake fan chosen for this testing was not operating at the calculated airflow. The smoke remained within the top one-quarter of the structure and tended to drift towards the southern portion of the building (toward the flotation and filtration area). As test personnel walked through the secondary grinding area, it was very difficult to feel the intake air being delivered into the structure by the intake fans. Since the walkway was only 30 ft below the intake fans, airflow should have been perceivable at this level.

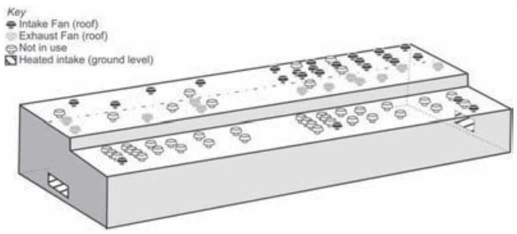


Figure 7. Ventilation setup #3.

Table 1. Average respirable dust concentrations in mg/m^3 for three ventilation setups.

	Setup #1		Setup #2		Setup #3
Location	Day	Night	Day	Night	Day
Primary # 2	1.06	1.21	0.66	0.38	0.44
Primary # 4	0.72	0.70	0.59	0.59	0.45
Primary # 6	1.15	1.34	1.37	1.49	0.98
Primary # 8	1.23	1.34	1.18	1.23	0.86
Primary # 10	–	0.97	1.05	0.91	0.72
Primary # 12	0.67	0.72	0.79	0.88	0.75
Average	0.97	1.05	0.94	0.91	0.70
Pebble # 1	0.32	0.38	0.38	0.31	0.29
Pebble # 3	0.42	0.42	0.47	0.51	0.42
Pebble # 6	0.34	0.35	0.48	0.50	0.35
Pebble # 9	0.49	0.50	0.51	0.56	0.49
Pebble # 12	0.38	0.41	0.36	0.43	0.38
Average	0.39	0.41	0.44	0.46	0.38
Flotation # 3	0.25	0.32	0.35	0.34	0.24
Flotation # 9	0.27	0.34	0.45	0.40	0.31
Average	0.26	0.33	0.40	0.37	0.27

Because the intake air appeared to be drifting towards the flotation and filtration area, it was decided to modify the ventilation setup to provide a greater quantity of the intake air moving in the northern direction towards the primary grinding mills. Figure 7 indicates the second modification to the ventilation design which was evaluated for approximately 8 hours during the last day of testing. This ventilation setup was composed of 24 exhaust fans and 12 intake fans, along with the two heater intake fans. The volume of air exhausted from the structure was approximately 32,000 m^3/min (1,128,000 cfm), with 29,600 m^3/min (1,045,000 cfm) being brought into the structure through the roof intake fans and two heater fans. The amount of intake air was identical to the previous test, but the exhaust was increased in an attempt to decrease the flow toward the flotation and filtration area while increasing the airflow to the primary grinding mill area.

Table 1 shows the average respirable dust concentration as determined by the instantaneous respirable dust monitors used in this study and provides a comparison of the three different ventilation designs tested. Obviously, the last ventilation design was the most effective at lowering respirable dust levels, particularly in the primary grinding area, which was the main area of concern. When compared to the average of the first two ventilation designs, the last design lowered respirable dust concentrations in the primary grinding area by 31 and 25 pct, respectively. This is a very significant reduction when one considers it was achieved by using the existing fans and simply varying the intake and exhaust flow quantities. Additionally, respirable dust levels were also slightly lower in the pebble mill and the flotation and filtration areas with the last ventilation setup. This study indicates the impact that ventilation can have on lowering respirable dust levels throughout a large-volume iron ore processing structure.

4 CONCLUSIONS

A cooperative research effort was established between the Tilden Mining Company LC, the United Steelworkers of America, and the National Institute for Occupational Safety and Health in an effort to lower respirable dust levels in Tilden's grinding and concentrator facility located in Ishpeming, Michigan. The two most significant impacts in this cooperative effort dealt with ventilation changes. The first change was to minimize the amount of air traveling through a reclaim tunnel before flowing into the basement of the structure. As the air moved through this reclaim tunnel, it entrained a substantial quantity of respirable dust generated from the twelve conveyor lines. As this dust laden air then entered the main structure through a connecting tunnel, it caused respirable dust levels to be 61 pct higher on the western side of the building as compared to the eastern side. In an effort to eliminate this occurrence, a seal on the very eastern side of the structure, where the reclaim tunnel accessed the outside environment, was rebuilt. In addition, a new seal was installed where the reclaim tunnel accessed the main structure. Both of these seals substantially lowered the amount of air flowing through the reclaim tunnel and entering the main structure. Although this lower air flow caused dust levels in the reclaim tunnel to be higher at some locations, this was not a significant factor since personnel are not normally in this tunnel. The benefit of this change was that respirable dust levels were lowered in the western side of the main grinding area to a point that they were the same as on the eastern side of the structure.

The second and more significant improvement identified in this cooperative research effort was accomplished by modifying the way the entire structure was ventilated. The effort involved monitoring respirable dust levels throughout the entire structure for three ventilation schemes. The first setup tested was as the structure was normally ventilated (by Tilden). For this setup, the exhausted air was over three times greater than the intake air, which caused the structure to be under negative pressure. For the second setup, the ventilation was changed to a more balanced design and improved airflow pattern within the structure. Based upon the configuration of the fans, it was decided to bring the intake air into the building at the center of the structure and exhaust it northward toward the primary grinding mills and southward toward the flotation and filtering areas. A smoke flare released into one of the intake fans indicated that a substantial portion of the air was drifting south towards the flotation and filtering areas, than was flowing north. Moreover, although the intent was to lower respirable dust levels throughout the entire structure, the main priority was to lower levels in the primary grinding area, where workers were required to wear respirators.

A third ventilation setup was tested which increased the number of exhaust fans in the northern portion and reduced them in the southern portion of the structure. This last ventilation design was the most effective of the three tested and provided a 31 pct reduction in respirable dust levels in the primary grinding area when compared to average levels measured for the first setup. Average respirable levels were also slightly lower in the pebble mill and flotation and filtration areas. This is a substantial reduction when considering that it came about by creating a more balanced flow pattern, but still using the same amount of fans.

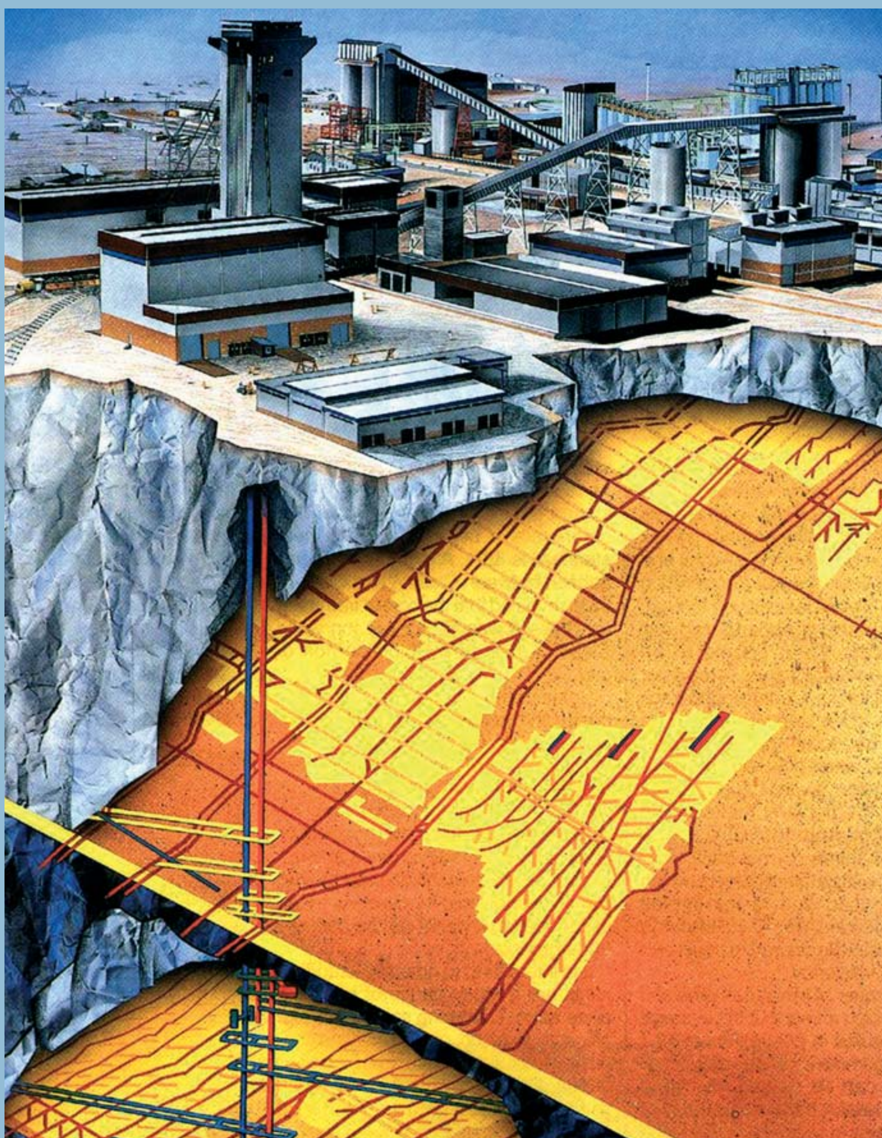
In closing, both of these research efforts indicate the significant and cost-effective impacts that ventilation changes can have on lowering respirable dust levels in a very large iron ore facility.

ACKNOWLEDGEMENT

The authors would like to acknowledge Leonard R. Parker, Manager-Safety & Environmental, Dave Wickstrom, (Previous) Union Safety Chair, Bill Vivian (Union Safety), Greg Magnuson (Ventilation), Dan Sleeman (Ventilation), and Scott Rasmussen, Area Manager-Concentrator Operations, for all their help and assistance in this research effort.

REFERENCE

Industrial Ventilation – A Manual of Recommended Practices, 2001 – 24th edition (American Conference of Governmental Industrial Hygienist: Cincinnati).



11TH

U.S./NORTH AMERICAN MINE VENTILATION SYMPOSIUM

2006

Editors:
Jan M. Mutmansky
Raja V. Ramani