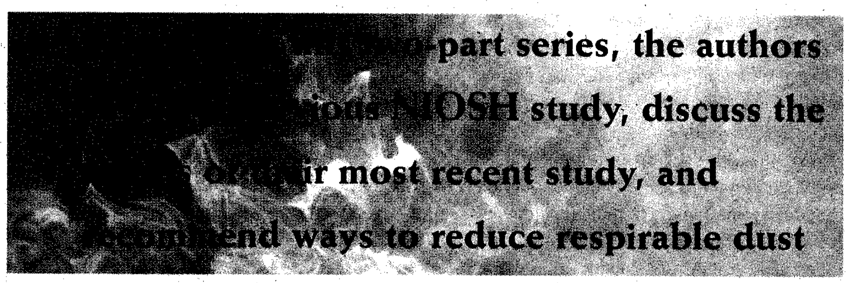
Respirable Dust Evaluation

of Two Portland Cement Operations - *Part 2*



by Andrew B. Cecala, Robert J. Timko, Jeanne A. Zimmer and Edward D. Thimons

In Part 1 of this series, the authors discussed a recent study that evaluated dust levels at two portland cement operations to determine how measured dust levels relate to a dust standard change being proposed by the Mine Safety and Health Administration (MSHA). These two operations differed in that one used the dry- and the other the wet-processing technique.

At both operations, respirable dust measurements were taken throughout the entire cement making process. In addition, measurements were taken on the perimeters of the properties to determine relative dust quantities traveling toward adjoining residential areas.

Evaluations were performed at each operation during the summer and winter to compare dust levels in both weather conditions. Area samples were collected to investigate problem areas with the goal of making recommendations on ways to lower dust levels in areas with higher concentrations.

Previous NIOSH study

From 1979 to 1982, the National Institute for Occupational Safety and Health (NIOSH) performed environmental studies at 16 cement operations throughout the United States, selected by looking at factors such as age of the operating kiln and the type of process used. During these evaluations, samples were collected and analyzed for various toxic agents, including respirable and total dust, free crystalline silica, aluminum, cobalt, magnesium, manganese, nickel, asbestos, nitrogen dioxide, oxides of sulfur, and other trace elements.

Both personal and area sampling were performed during these evaluations. Medical testing of workers also was performed to determine the prevalence of respiratory disease within a few weeks of the environmental analysis. For the medical testing, more than 2,730 cement plant workers were analyzed and compared to a control group of 755 workers. The control group was composed of workers from 10 plants in various non-cement-type industries. This study also looked at the smoking status of cement plant workers, as well as for the control group. A summary article on this research was published in the *British Journal of Industrial Medicine* (1988).[1]

In the course of this study, there were 1,011 personal respirable dust samples taken and 211 personal total dust samples. The geometric mean dust concentration of the 1,011 personal respirable samples was 0.57 mg/m³, with 5% of the samples exceeding the 5-mg/m³ level. The geometric mean dust concentration for the 211 personal total dust samples was 2.90 mg/m³, with 19% of the samples exceeding the total dust standard of 10 mg/m³.

Quartz was the only contaminant found in excessive concentration. Quartz was detected in 14.4% of the personal respirable dust samples when analyzed for crystalline silica with a median concentration of 0.079 mg/m³. Respirable quartz was found most often in the quarry, primary crusher, primary grinding, and processing mills. The number of samples with detectable quartz varied significantly among plants and was primarily believed to be correlated with variations in the raw material. No cristobalite was found in any samples taken.

The only other mention of a contaminant other than respirable/total dust and crystalline silica was a low level of hydrogen sulfide found at one operation. This was believed to be associated with the limestone quarry water. Little adverse effect of cement plant dust on respiratory symptoms and ventilatory function was found in this study. However, the prevalence of radiographic abnormalities consistent with pneumoconiosis was low but significantly elevated from the norm. Considering the size of this study and the comprehensive nature of the exposure sampling, the main concern in cement plants should be controlling total and respirable dust levels, with special emphasis on controlling silica dust.

Discussion

The field evaluation portion of the more recent study was performed during an 18-month period comparing dust concentrations in both summer and winter conditions at a wet- and a dry-processing cement operation. This research effort was initiated in 1995 during a time when the Bureau of Mines was being eliminated. This impacted funding levels, thus affecting the number and locations of operations evaluated.

Two evaluation sites were chosen to meet the research objectives, but it must be remembered that they provide a small picture of the industry as a whole. However, combined with the data from the earlier NIOSH study, it provides a meaningful look at dust levels in cement operations.

Respirable dust concentrations at the various sampling locations measured at the dry-processing operation ranged from 0.04 to 16.02 mg/m³. The average respirable dust concentration for both summer and winter surveys was 2.52 and 0.07 mg/m³ for the plant and environmental monitoring locations respectively. The only location above the 5-mg/m³ average was the clinker cooling tunnel, which averaged 16.02 mg/m³ during the August survey. This value had a great impact on the overall plant average, raising it by 1.12 mg/m³.

It should be noted that plant personnel are seldom in this tunnel, and when necessary, it is normally not for extended periods of time. The main reason for high dust levels at this location was due to the conveyor line being located underground with no controls to clear the dust liberated during product conveying. There also were high dust readings at the feedside end of the kilns for the first few sampling segments during the August survey, which was due to a dust leak in the system. Once this problem was corrected, dust levels remained at less than 1.1 mg/m³ for the remainder of the test.

There also were a few locations during the August survey that measured a higher dust reading for one sampling period than the others, and this was most likely due to a leak in the system or maintenance work. The first-floor ball mill location recorded a 5.29-mg/m³ average for the first 7½-hour sampling segment during the afternoon shift for the first day of testing. A similar occurrence was measured at the second-floor ball mill location for nearly 7 hours during the second morning of testing and for the third sampling segment. There were no significant variations during the December analysis.

Overall, dust levels at the dry-processing operation were at acceptable levels during the times of the two surveys based upon current and proposed regulations. The only problem area was the clinker cooling tunnel location and recommendations to lower dust levels for this tunnel location will be given. Excluding the clinker cooling tunnel, the average plant dust concentration for all locations monitored for the two dust surveys was 1.40 mg/m³. The average environmental dust concentration was 0.07 mg/m³, which represented no significant contamination to occupied areas around the facility during the two surveys.

Dust levels at the wet-processing operation ranged from 0.03 to 14.72 mg/m³ for the summer and winter dust surveys with a plant average of 2.73 mg/m³ and an environmental average of 0.12 mg/m³. For the plant monitoring locations, there were two locations with high respirable dust concentrations, the clinker slope conveyor and discharge-end fifth-floor kilns. Both of these locations were measuring dust generated by clinker product as it traveled on the beltway to the cooling storage area.

During the summer analysis, both of these locations were impacted during cleanup work by the summer work force (11.88 and 14.72 mg/m³). Even though dust levels were lower during the winter analysis at both of these locations, they were still at levels that would have significantly impacted a worker's dust exposure if they had spent a good portion of their work day in these areas (6.39 and 5.06 mg/m³). Recommendations to lower dust levels in these two areas will be presented.

Dust levels at the remainder of the plant monitoring locations appeared to be at acceptable levels during the times of the two surveys based upon the proposed dust regulations. One concern identified at the second plant was the housecleaning work crew. These workers are at high dust exposures while performing this type of work. This operation hired summer workers to primarily perform this housekeeping effort.

There was very limited environmental monitoring done at this facility due to the weather conditions. Dust levels were recorded at four locations in July and two locations in February with an average dust exposure of 0.12 mg/m³. Although this value is slightly higher than the average at the first plant, dust levels were still at levels that did not pose a problem to the neighboring community during the evaluation period.

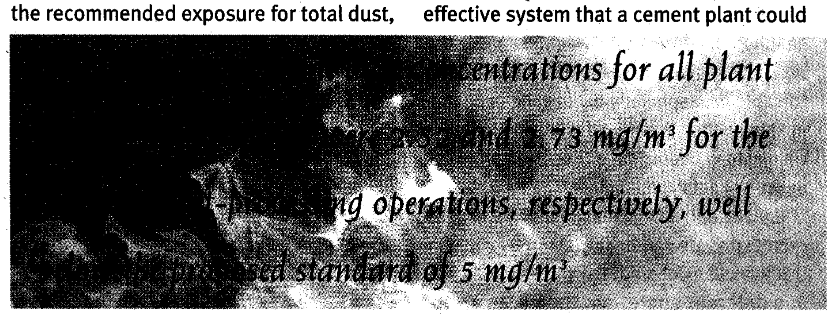
Overall, the results of testing at both the dry- and wet-processing facilities were in line with the previous study performed by NIOSH. At the 16 operations analyzed in the previous study, there were a minimal number of personal dust samples that exceeded the recommended exposure for total dust, respirable dust, or silica, as well as a few operations with no over exposures. Again, the intent was to take area samples in an effort to investigate problem areas with the goal of being able to make recommendations on ways to lower dust levels in areas with higher dust concentrations.

Recommendations

Probably the area of greatest concern was confined areas used to transport product material within the process. This was seen at the clinker cooling tunnel at the first operation and clinker slope conveyor and discharge-end fifth-floor kilns sample location at the second site. These locations were all similar in that product was being conveyed on a beltway in the confined area with very little or no supplied ventilation. Because of the lack of ventilation, any dust liberated remained trapped in the confined area and built up over time to significant dust levels. These areas should be furnished with a ventilation system to provide fresh air to remove dust-laden air from the area. This air should be filtered through some type of collecting system.

While discussing ventilation, another recommendation is to provide total mill ventilation to large structures. The use of this ventilation system can lower all workers' respirable dust concentrations working within these structures.[2] This system uses a bottom-up approach. Clean make-up air is brought in at the base of the structure and sweeps upward through the building, clearing dust-laden areas. This air is then discharged at or near the top of the building where it will not contaminate plant personnel working outside.

In addition, thermodynamic effects of the heat generated by plant equipment will assist the basic flow pattern of this ventilation system. This is probably the most cost-effective system that a cement plant could



implement to lower dust levels throughout any processing building. Dust reductions of 40% to 80% with these ventilation systems have been recorded at similar structures in other industries. This is the most cost-effective technique to achieve these types of dust reductions if you consider installation, maintenance, and operating costs.

Another possible area for improvement is housekeeping practices. At the first operation, daily cleanup was observed in some areas of the plant and although this is good, sweeping and shoveling was the method used to perform this housekeeping effort. Sweeping and shoveling methods create a substantial amount of dust and expose the cleanup workers to higher dust levels. The first thing to do is to better seal leakage areas so housekeeping does not need to be performed as often.

When daily cleanup is performed, exhaust ventilation, or water wash-down methods are the preferred housekeeping techniques. Some operations use a centralized building vacuuming system with hookup ports located on various floors. This makes the clean-up process convenient and promotes good housekeeping. Many of these systems also have outside dust dropouts into truck tanks, which simplifies the disposal of the collected dust.

At the second operation, a summer work crew was performing mill housekeeping and cleanup. Housekeeping should have been performed more often so that the build up was not so extensive. Dust levels were 46% and 66% higher during the summer survey at the two locations, directly impacted by the housekeeping. This had a great impact on dust exposure of the cleanup workers.

Another recommendation is to provide cleanup and maintenance workers with positive-pressure-type respirators to increase their respiratory protection. Positive-pressure respirators essentially eliminate the sealing concerns with a negative-pressure type while also providing for a more comfortable fit, especially during the hot summer months. Positive flow air purifying respirators should be either the half-mask or air-helmet type.

It also should be stressed that a worker's dust exposure can be impacted by the way the job is performed. During a field study at a different operation, there was a substantial variation in the dust exposure of two workers performing the same job function based on differences in individual work practices or techniques. Even with the housekeeping practices, there can be a significant difference in dust generated depending on how the worker performs the cleanup function.

One last area deals with cleanliness of a workers' clothes. Researchers measured dust exposure increase of 10 times base levels resulting from a worker with soiled work clothes. Contaminated work clothes can be a major problem for some operations especially during the winter months, when workers wear heavy work coats. Many workers may wash their coats only periodically throughout the winter months, and these coats have the potential to be a significant source of personal dust exposure. Operations should consider providing either disposable coveralls or washing coveralls for their workers to minimize this dust source.

Conclusion

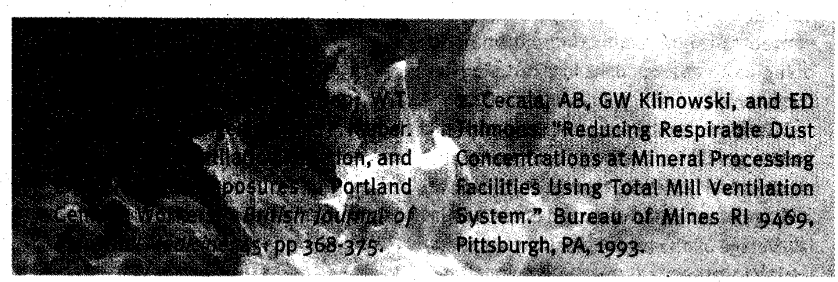
When this research was initiated in 1995, the dust standard was 10 mg/m^3 total dust limit with a proposed 5 mg/m^3 respirable dust standard being proposed for metal/nonmetal operations. This also would provide insight into the potential impact of the dust standard change on the cement industry.

For this study, dust measurements were taken at a dry- and a wet-processing operation for 48 to 68 hours of continuous sampling during summer and winter surveys at both operations. Area dust measurements were taken for this study using instantaneous and gravimetric sampling instrumentation, which eliminated many of the biases of taking personal dust measurements. This allowed for a determination of high-dust exposure areas of the plants. Recommendations were presented on ways to reduce dust levels in these high-exposure areas.

Overall, plant dust levels appeared to be at acceptable levels based on the proposed standard of 5 mg/m^3 respirable dust. The average respirable dust concentrations for all plant monitoring locations for both summer and winter surveys were 2.52 and 2.73 mg/m^3 for the dry- and wet-processing operations, respectively. There were a number of areas identified that were well above this average and could cause workers to be exposed to high dust levels if they spent a significant part of their work day in these areas. Recommendations were presented to lower dust levels in these areas, and some general recommendations were made for all workers.

Environmental dust measurements also were taken on the perimeter of both plants near residential areas to determine relative dust levels traveling toward these areas. These measurements were not taken to indicate any compliance with the U.S. Environmental Protection Agency regulations but just to indicate relative concentrations as compared to plant dust levels. In all cases, respirable dust levels were at low levels and ranged from 0.03 to 0.19 mg/m^3. Dust levels leaving the perimeter of the property of these two facilities were at acceptable levels during all testing periods. As this dust continued to flow toward residential areas, it would continue to be further diluted as it became mixed with outside airflow. CA

All the authors are with the Dust and Toxic Substance Control Branch at the Pittsburgh Research Laboratory for the National Institute for Occupational Safety and Health. Andrew B. Cecala is a mining engineer; Robert J. Timko is a supervisory research physical scientist; Jeanne A. Zimmer is a physical scientist technician; and Edward D. Thimons is branch chief.



W.T. ... ber. ... ion, and ... posures ... Portland ... Cement Workers" *British Journal of* ... pp 368-375.

2. Cecala, AB, GW Klinowski, and ED Thimons. "Reducing Respirable Dust Concentrations at Mineral Processing Facilities Using Total Mill Ventilation System." Bureau of Mines RI 9469, Pittsburgh, PA, 1993.