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296

EVALUATION OF VENTILATED SANDERS IN THE AUTOBODY REPAIR INDUSTRY*

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Orbital and reciprocating sanders were evaluated in autobody shops to obtain information on the ability of the sanders to control worker dust exposures. Air is exhausted from ventilated sanders at a rate of 0.25 to 1.0 m³/min. When unventilated sanders were used, short-term total dust exposures ranged between 2 and 170 mg/m³. When ventilated sanders were used, short-term total exposures ranged between 0.22 and 1.2 mg/m³. Aerosol photometer measurements showed that ventilation decreased dust exposure by a factor of 10 when body-filling compound was sanded. These results indicate that the use of sanders equipped with high-velocity, low-volume ventilation should be encouraged in the autobody repair industry.

During autobody repair, sanding is performed to remove paint from a surface and to smooth body panels that have been repaired with body-filling compounds. Short-term total dust exposures as high as 40 mg/m³ have been reported during the sanding of body-filling compounds.[1] Such exposures can be excessive in relation to the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for total dust, an eight-hour time weighted average (TWA) of 15 mg/m³. Exposures may also exceed the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for total dust, an eight-hour TWA of 10 mg/m³.[2,3]

To minimize such dust exposures, some autobody shops use mechanical sanders that are equipped with high-velocity, low-volume (HVLV) ventilation as part of the tool's design. As shown in Figure 1, air is exhausted through holes in the sander pads and sand paper.[4,5]

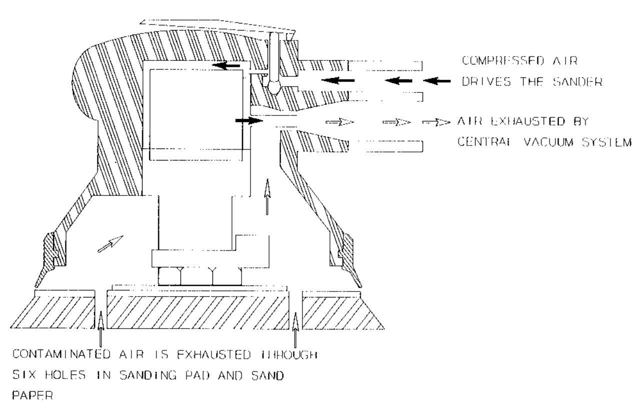

FIGURE 1. Schematic of a 15-cm diameter orbital sander with HVLV ventilation

These sanders have either a straight-line or a rotary/orbital sanding motion. For orbital/rotary sanders, the sanding pad has a diameter of 10 to 20 cm. It usually has between 6 and 12, 1-cm diameter holes located 1 to 3 cm from the outer edge. The sanding pad of a straight-line sander is usually 7 to 8 cm wide and 40 to 50 cm long. Along the length of the sanding pad are two rows of nine equally spaced 1-cm diameter holes. These holes are 1 cm from the edge of the sanding pad.

Sanders equipped for HVLV ventilation typically cost between $20 and $40 more than the same sanders without HVLV ventilation. In the autobody repair industry, ventilated sanders often are used with a central vacuum system. Such a system involving 22 workstations, a bag house to clean contaminated air, and a 15 hp turbine blower was reported to cost $38,000 in 1987.[4]

During a study of controls for air contaminants in autobody shops, ventilated sanders were evaluated because of an

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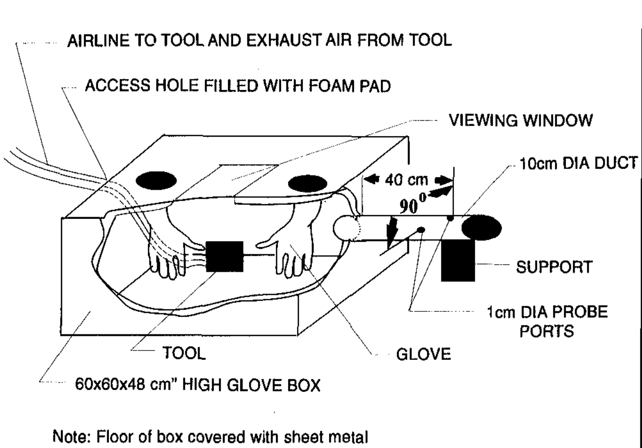

FIGURE 2. Apparatus for measuring the exhaust airflow of ventilated tools

absence of information on their efficacy. Furthermore, the ventilated sanders were evaluated because they appeared to effectively control the excessive dust exposures that can occur when body-filling compound is sanded. Sanding with HVLV-equipped tools was evaluated in three shops and sanding without HVLV tools was evaluated in two shops.

TABLE I. Short-Term Total Dust Exposures for Sanding Plastic Body-Filling Compound

Sander	*Short-term total dust exposure (mg/m³)*	*Airflow (m³/min)*
Ventilated sanders		
straight-line	1.2	0.51
straight-line	0.45	0.54
straight-line	0.67	0.54
straight-line	0.22	0.54
GM (GSD)[A]	0.53 (2.0)	
Nonventilated sanders		
straight-line	2.0	
rotary	86	
rotary	170	
non reported[B]	39	
non reported[B]	5	
GM (GSD)[A]	22 (4)	

[A]Based upon the Smith-Sattertwaite t-test for nonhomogeneous variances, the geometric means (GM) are different (probability $>$ t = 0.001).
[B]Data from Jayjock and Levin[1]

PROCEDURES

Flow Rate Measurements

Before air sampling was performed at each study site, the exhaust flow rates from ventilated sanders were measured using the apparatus illustrated in Figure 2. Each sander was placed in this apparatus, and the access hole for its hoses was sealed with foam padding. The air velocity into the duct described in Figure 2 was measured with a hot wire anemometer (Model 1040 Digital Air Velocity Meter, Kurz, Carmel Valley, Calif.). The sander's exhaust flow rate was measured while sanding sheet metal on the bottom of the apparatus. The exhaust flow rate was calculated as the product of the duct's cross sectional area and 0.9 times the air velocity at the duct's centerline.[6] Because the air velocities at the center point fluctuated 20 to 30%, a traverse could not be justified.

Real Time Exposure Monitoring

An aerosol photometer (Hand-Held Aerosol Monitor (HAM), PPM, Inc., Knoxville, Tenn.) was used to measure relative dust concentrations. The HAM was used with the following settings: time constant, 1 second; range, 0–2 mg/m³. The worker's activities were concurrently videotaped and the HAM's analog output was recorded with a data logger (Rustrak® Ranger, Gulton, Inc., East Greenwich, R.I.). The HAM's analog output is reported in volts. This was done to emphasize the fact that the response of an aerosol photometer varies with the particles' optical characteristics and size.[7] When the data collection was completed, the data logger was downloaded to a portable computer. Videotapes were reviewed to prepare annotated plots of the HAM's analog output versus time.

Air Sampling

Air samples were collected by drawing air through a calibration manifold mounted on the HAMs or directly into a filter cassette mounted in the worker's breathing zone. The HAM's calibration manifold allows collection of an air sample after the aerosol has passed through the sensing chamber. The filter cassette contained a 37-mm polyvinyl chloride filter with a 5-μm nominal pore diameter. Air sampling was conducted with either a calibrated personal sampler operating at 3.5 L/min or a critical orifice operated at a flow rate of 13 L/min. The polyvinyl chloride filters were analyzed for weight gain using NIOSH Method 0500.[8]

RESULTS AND DISCUSSION

Table I summarizes short-term dust exposure measurements for sanding with and without ventilation. The sander ventilation rates ranged between 0.40 and 0.99 m³/min for sanding body-filling compound or painted surfaces. As summarized in Table I, the geometric mean short-term dust exposure for sanding with ventilated sanders was 0.5 mg/m³ versus a geometric mean of 22 mg/m³ for sanding body-filling compound without ventilation. Based on the Smith-Satterthwaite t-test for nonhomogeneous variances, this difference is significant (probability $>$ t = 0.001).[9] The data in this table was obtained from various sites and is confounded by the type of sander used (rotary/in-line).

In addition, two concentration measurements for the nonventilated sanders were taken from the data of Jayjock and

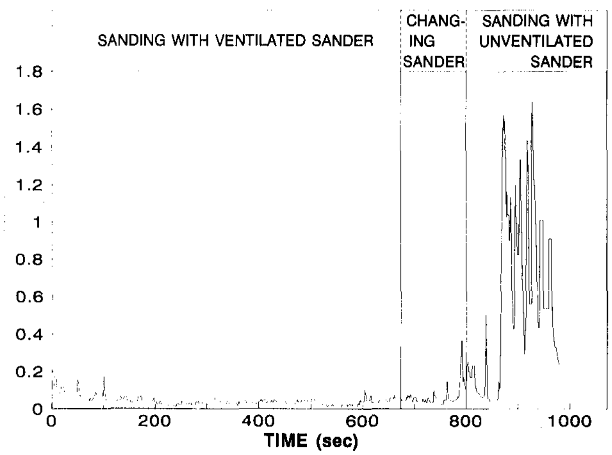

FIGURE 3. HAM analog output when sanding with a ventilated and an unventilated straight-line sander

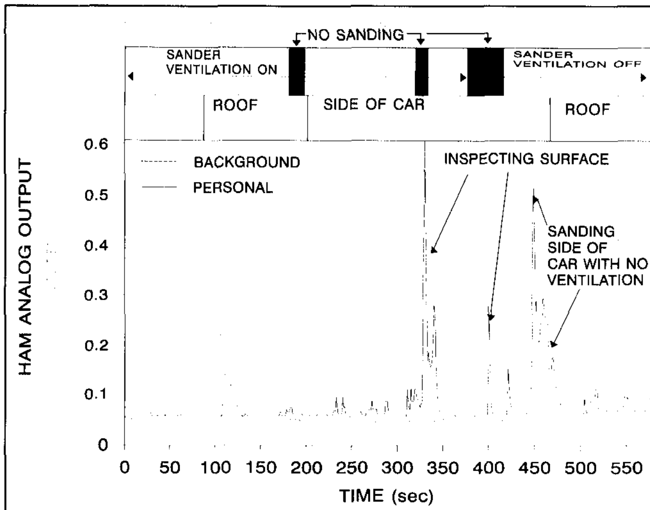

FIGURE 4. HAM analog output while sanding on side and roof of a car with a rotary sander

Levin.[1] During one sampling session when an unventilated sander was used to sand body-filler compound, a dust exposure of only 2.0 mg/m^3 was measured. While this sample was collected, the worker used a man-cooling fan to disperse the dust throughout the shop. A total dust concentration of 10 mg/m^3 was measured downwind of this worker.

The observed concentration difference may be caused by the different types of nonventilated sanders studied and differences in the car parts being sanded. However, the data indicates that sanding body-filling compound without ventilation can cause unacceptable dust exposures when done for appreciable time periods. Figures 3 and 4 show that the HAM's analog output increased dramatically when the worker changed from a ventilated to a nonventilated sander.

Figure 3 presents the HAM's analog output while a worker was using a straight-line sander to smooth out body-filling compound that had been applied to a car door. In order to demonstrate that these ventilated sanders actually reduce worker dust exposure, this worker briefly sanded with a nonventilated sander. The HAM's analog output averaged 0.05 volts while the worker used a ventilated sander. When he switched to the nonventilated straight-line sander, the average analog output was 0.57 volts.

Figure 4 displays the HAM's analog output when a ventilated rotary sander was used to remove paint from the hood and the side of a car. When the worker sanded with ventilation, the HAM's analog output averaged 0.06 volts. When the worker sanded the side of the car with the ventilation temporarily detached, the HAM's analog output increased to an average of 0.16 volts. When the worker sanded on the car's roof without ventilation, visible dust emissions were present. However, the HAM's analog output decreased to an average of 0.07 volts. Sanding the roof of the car without ventilation caused the HAM's analog output to decrease because the sander was held farther from the worker, and the dust did not appear to enter the worker's breathing zone.

Although the ventilated sander controls much of the airborne dust, two exposure peaks, annotated in Figure 4, occurred when the worker brushed the surface of the car to inspect the surface smoothness. This relatively gentle motion caused a noticeable dust exposure because the worker's face was close to the surface during visual inspection. During the time that the worker was inspecting the surface of the car, the HAM's analog output averaged 0.12 volts, which was higher than the average analog output when the ventilated sander was in use. Thus, the sander's HVLV ventilation does not address all the potential sources of dust exposure during sanding operations.

The autobody repair technicians who participated in the study generally preferred to use the ventilated sanders because their use resulted in a cleaner shop. The use of ventilated sanders can be enhanced by making them convenient to use. At some shops, the flexible hoses and ventilated sanders were kept at a central location, and the workers had to collect this equipment for each job. This led to some sanding without using the central vacuum system. One shop avoided this problem by installing retractable, flexible hosing attached to the piping for the central vacuum system.

CONCLUSION

In the autobody repair industry ventilated sanders can provide a significant reduction in worker dust exposures. This control approach involves the use of a modest quantity of exhaust ventilation to remove air contaminants close to the point of generation. The incremental cost for installing these controls appears to be quite modest.

ACKNOWLEDGMENT

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