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Assessment of Asbestos Exposure Associated with a Brake Grinder

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Abstract

The wear patterns for drum-style automotive brakes tend to enlarge internal drum diameters. Such enlargement is most profound when used brake drums are machined to restore the metal friction surfaces. Specialized arc grinding machinery has been used to match replacement shoe-style brake friction materials to enlarged drums. The process of arc grinding removes friction material, thereby producing dust. When organic-style friction materials contained asbestos, use of arc grinding machinery posed an asbestos fiber exposure risk to operators and proximate personnel. The manufacturers of arc grinding machinery have incorporated local exhaust ventilation systems designed to capture and remove this dust at the point of grinding contact and propel this dust into collection bags or other systems. This research was designed to evaluate the dust capture and retention characteristics of a specific arc grinder product, when used to custom grind asbestos-containing brake friction materials. A Bear Model 1420 automotive brake shoe arc grinder was the subject of this study. During two separate but consecutive test sessions, newly relined sets of shoe-style automobile brake friction materials were precision ground. Both area and personal air samples were collected throughout each testing session. This work took place within a closed and unventilated metal building, with total interior volume of 2500 m^3. Collected air samples were analyzed using phase contrast microscopy (PCM) and transmission electron microscopy (TEM). The results of analysis using PCM for personal samples (n = 6) ranged from <0.044 to 0.055 fibers per cc (f/cc) (mean 0.05). Follow-up analysis of these personal samples using TEM indicated asbestos-adjusted PCM exposures ranging from <0.0074 to 0.055 f/cc (mean ≤ 0.041). Area air samples, taken at distances ranging from 1.5 to 9 meters from the arc grinder (n = 12), showed asbestos-adjusted PCM concentrations ranging from <0.0075 to 0.041 f/cc (mean ≤ 0.017). The process of custom arc

grinding shoe-style, asbestos-containing brake friction materials can cause exposure to airborne asbestos fibers. However, when done using properly equipped arc grinding machines, such exposures are not expected to exceed the current occupational exposure limits for asbestos of 0.1 f/cc 8-hour time-weighted average (TWA) or 1.0 f/cc 30-minute average.

Keywords

Asbestos Exposure, Brakes, Arc Grinder, Friction Materials

1. Introduction

Automotive brake friction products often contained chrysotile asbestos until the early 1990s. Chrysotile content of brakes ranged from 33% to 73% by weight. Asbestos adds strength and flexibility and allows brake linings to be molded from powder. Asbestos adds heat resistance and acts as an aggregate with resins and other constituents. Arc grinders were used to match the radii of replacement brake linings with the worn turned brake drums. These machining operations could generate airborne dust. Asbestos exposure could result from use of arc grinders. Previous exposure assessments reported grinding of brake shoes was common during the 1960s and resulted in average 8-hour TWA asbestos exposures of approximately 0.10 fibers/cc. These exposures subsequently decreased to approximately 0.0021 fibers/cc in the 1980s [1] because of conversion to disc brakes and other improved exposure controls. We previously reported an exposure assessment using an AMMCO Model 8000 Brake Shoe Grinder with a dust collection system. The average personal asbestos fiber concentration of the arc grinding tests was 0.064 fibers/cc [2]. This study agrees with Weir *et al.* 2001 [3]. An additional exposure study during brake repair has been published [4]. These studies support the claim that arc grinding of asbestos-containing brake shoes may result in asbestos exposures below the current OSHA regulatory limits, and well below the historical OSHA regulatory limits. The objective of this study is to evaluate the exposure from an additional grinder. The BEAR Model 1420 was used for this exposure assessment. This grinder also used an exhaust collection system for generated dust.

2. Methods

A Bear Model 1420 automotive brake shoe arc grinder (**Figures 1-3**) was used to determine the potential for user and bystander asbestos fiber exposure during grinding operations involving asbestos-containing friction materials. Air samples, both personal and general area, were taken throughout and beyond the grinding periods. The arc grinder was fully outfitted with standard equipment, which included a shroud around the grinding rotor and a dust collection bag.

Two separate tests were conducted, each involving the custom grinding of

four separate brake shoes. The brake shoes utilized for testing were designed to fit 12-inch diameter drums having a friction surface width of 2 1/2 inches. Analysis of the brake friction materials utilized indicated chrysotile asbestos contents of 45% (by area) as determined using polarized light microscopy

Figure 1. Bear Model 1420 automotive brake shoe grinder.

Figure 2. Bear Model 1420 verification decal.

Figure 3. Bear Model 1420 abrasive surface and shoe attachment.

The drum-style brake shoes used for this testing had been relined, a process that involved installation of asbestos-containing friction materials that were fastened using rivets. The first of two grinding tests conducted involved truing the friction materials to the standard 12-inch diameter. For the second test, these same brake shoes were ground to custom fit a drum having 12.020-inch inside diameter. Grinding activities consumed 13 minutes during the first test and just short of 9 minutes for the second test.

Three separate personal air samplers were worn by the grinder operator during each test. One of these personal samplers was stopped after 15-minutes run time, while the two remaining samples were left running atop the grinding machine for an additional 15 minutes. This sampling strategy was chosen to provide data directly comparable against OSHA's PELs for asbestos, including the previous 15-minute duration ceiling limit and current 30-minute excursion limit.

Separate fixed-area air samples were collected during each test at positions five feet distant from the grinder to the north, south, east, and west. Two additional area air samples were collected near the east and west building walls, approximately 20-feet distant from the grinder position. All indoor area air samples were run for 30 minutes during each test.

All test-period air samples were submitted for analysis using PCM, per NIOSH 7400. For those samples showing the presence of fibers (those longer than 5 micrometers and wider than 0.25 μm), further analysis was conducted using TEM, per NIOSH 7402.

3. Results

When analyzed using PCM, neither of the 15-minute duration personal samples from either test session showed the presence of fibers at or above the 0.064 fibers/cc (f/cc) lower detection limit. Similar analysis of the 30-minute duration air samples from both tests indicated the presence of fibers in concentrations ranging from 0.044 to 0.055 fibers/cc, average 0.05 f/cc (Table 1).

Table 1. Personal air sampling results.

Test procedure	Sample collection		PCM analysis	TEM analysis	Asbestos-Adjusted PCM
	Time (min)	Volume (L)	Ø[a]	Fiber ratio	Ø (f/cc)
1. *Arc grind relined brakes*					
	15	30.3	<0.064	---	<0.064
	30	60.7	0.055	0	<0.0074
	30	60.7	0.047	0.5	0.024
2. *Custom grind brakes to* 12.02 *inch diameter*					
	15	30.3	<0.064	---	<0.064
	30	60.7	0.055	1	0.055
	30	60.7	0.044	0.67	0.029

PCM and TEM analyses were completed according to NIOSH 7400 and 7402, respectively. --- Not analyzed, as no fibers detected using PCM. [a]Average fiber concentration during each test duration.

Follow-up analysis using TEM showed the presence of non-asbestos fibers, yielding asbestos-adjusted concentrations for the combined tests ranging from <0.0074 to 0.055 f/cc, average ≤ 0.041 f/cc (Table 1).

Six area air samples were collected during each test session, four within five feet from the grinder and two at 20-feet distant. All of the indoor area air samples for both testing sessions ran for periods of 30 minutes. Analysis of samples from the first testing session, when done using PCM, showed airborne fiber concentrations ranging from <0.0075 to 0.028 f/cc, average 0.015 f/cc. The overall range of concentrations did not change following TEM analysis; however, the average of asbestos-adjusted concentrations dropped to ≤0.013 f/cc.

The second testing session directly followed the first and the test facility was not ventilated during the interim period. Analysis of area air samples using PCM showed airborne fiber concentrations ranging from <0.0075 to 0.041 f/cc, average 0.026 f/cc. As with the first test, follow-up analysis using TEM did not change the overall range of concentrations; however, the average of asbestos-adjusted airborne fiber concentrations dropped to 0.021 f/cc.

4. Conclusion

It appears from the personal air sample results that the Bear arc grinder's exhaust ventilation system successfully captured and removed respirable-sized particles from the operator's breathing zone, thus the absence of detectable fibers for the short-term personal samples. Based on the area sample results and those for longer-term personal samples, some quantities of respirable-sized asbestos fibers appear to have escaped the collection bag and were dispersed within the testing facility, where the average asbestos-adjusted airborne fiber concentrations reached ≤0.013 fibers/cc during the initial arc grinding session and ≤0.021 fibers/cc during a second session, done in rapid series. At the highest, these measured 30-minute concentrations are at least 35 times less than OSHA's 1.0 f/cc excursion level. If projected to 8 hours, assuming no additional exposure during the unsampled period, the exposure concentrations would be ≤0.0008 and ≤0.002 fibers/cc as 8-hour TWAs for the first and second testing sessions, respectively.

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Conflicts of Interest

CB and RH have testified in matters involving asbestos-containing brakes.

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