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EXHIBIT 247

Morphological Characteristics of Asbestos Fibers Released During Grinding and Drilling of Friction Products

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There has been considerable interest during the past 30 years regarding the potential for exposure to asbestos fibers generated during asbestos-containing automobile and light-duty truck brake replacement and repair operations. Less attention has been directed to asbestos fiber exposures resulting from servicing of brakes on heavy-duty trucks and other machinery. Potential for the generation of respirable fibers as a result of using a rotary bench grinder and the drilling of asbestos-containing friction pads was investigated to assess the characteristics of the fibers generated from these procedures. The data from the grinding process revealed that this material was either resin matrix or fibers bound to the resin matrix. Fibers generated from the drilling procedure revealed morphology consistent with chrysotile asbestos. In each case, nonfibrous materials remained bound to the fibers released from these processes. These fibers had resin deposits attached. This investigation offers evidence that drilling and grinding of brake pads generates fibers that, for the most part, remain bound to the underlying matrix, suggesting that grinding and drilling may not pose an important source of exposure to respirable asbestos fibers.

Keywords Asbestos, Automobile Brakes, Brake Repair, Brake Shoes, Drilling, Friction Materials, Grinding, Residue

Occupational safety professionals and health scientists have shown considerable interest during the past 30 years regarding the potential for exposure to asbestos fibers generated during asbestos-containing brake replacement and repair operations. Epidemiologic studies of this industry, however, have not provided conclusive or convincing evidence to suggest that exposure in these work activities will result in disease.[1–4]

Considerable attention has been directed to light-duty vehicular servicing where the majority of the estimated 150,000 to 900,000 persons may have had some potential for elevated exposure.[5–12] With few exceptions[13] there has been little or no investigation of fiber release from friction product applications such as those on heavy-duty trucks and buses or heavy motorized machinery, as well as a wide variety of industrial brakes.

Replacement and servicing of heavy-duty vehicular and industrial equipment brakes often required drilling of the friction pad to permit riveting or bolting to the shoe, band, or backing plate. In addition, it was often customary to bevel the leading edge of these pads on the consideration that a beveled surface would produce a smoother interaction between the brake and the opposing metal surface.

An investigation was conducted to assess the potential for the generation of respirable fibers that may be produced as a result of (a) using a rotary bench grinder to bevel the leading edge of asbestos-containing friction pads, and (b) drilling asbestos-containing friction pads. The purpose of this investigation was to assess the morphological characteristics of the fibers generated during these procedures.

METHODS

Brake pads that had previously been tested for asbestos content[14] were utilized for all tests. The pad material contained 50% ± 10% chrysotile asbestos in a phenolic or cresylic resin base along with a variety of friction surface modifiers.[15]

All procedures were conducted within a laboratory ventilation hood operated at a face velocity of approximately 0.5 meters per second. Grinding procedures utilized a 16 cm × 2.5 cm aluminum oxide 60/80 grit abrasive grinding wheel attached to an unguarded stationary bench grinder. The grinder was operated at a speed of 1,725 RPM and was located in the center and 15 cm into the fume hood to ensure capture of all residue. Air samples were collected using 25 mm mixed cellulose ester filters located in the direct air stream approximately 25 cm from the surface of the hood table, and approximately 15 cm lateral to the grinding plume.

Drilling procedures were conducted using a quarter-inch rotary drill fixed in a vertical position in the manner of a drill press. A quarter-inch bit was used for all drilling tests and was operated at a speed of 900 RPM. Numerous holes were drilled through each of four brake pads. Samples of the residue resulting from the drilling of these pads were collected into glass sample vials.

ANALYSES

For the grinding procedure, samples from this process were analyzed using NIOSH 239 and scanning electron microscopy/transmission electron microscopy (SEM/TEM) procedures.

Bulk material generated from the drilling procedure was evaluated using SEM/TEM and energy dispersive X-ray analysis (EDX). All electron microscopy was submitted to an accredited and licensed testing laboratory for analysis.(16)

RESULTS

Review of the data from samples collected during the grinding process revealed that the NIOSH 239 analytical procedure could not be utilized. The particulate density on the filters was greater than the working range of the method. All samples contained numerous particulate as well as fibrous material. The overwhelming majority of the particulate appeared to be resin matrix. The majority of fibrous material was bound to resin matrix.

The SEM/TEM analyses of these samples revealed many fibers with a morphology consistent with chrysotile asbestos. Energy dispersive X-ray (EDX) analysis provided further confirmation. Representative examples of fibers identified from the grinding procedure are presented in scanning electron microphotographs (Figures 1 and 2).

SEM/TEM analyses of fibers generated from the drilling procedure revealed many fibers with morphology consistent with chrysotile asbestos. EDX analysis provided further confirmation. Representative examples of fibers identified during the drilling procedure are presented in scanning electron microphotographs (Figures 3 and 4).

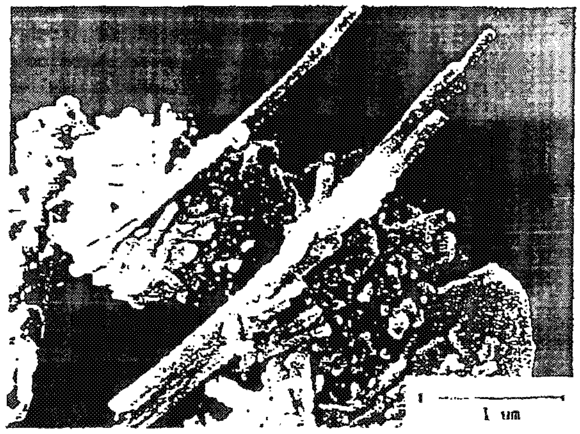

FIGURE 2
Scanning electron microphotograph of typical particulate matter observed from an air sample collected during the beveling of an asbestos-containing friction pad.

DISCUSSION

Results of the SEM/TEM analyses demonstrate that fibrous material containing asbestos can be removed from the pad by either grinding or drilling procedures. In each case, however, it is evident that nonfibrous materials remained bound to the fibers that were released from these processes as observed in Figures 1-4.

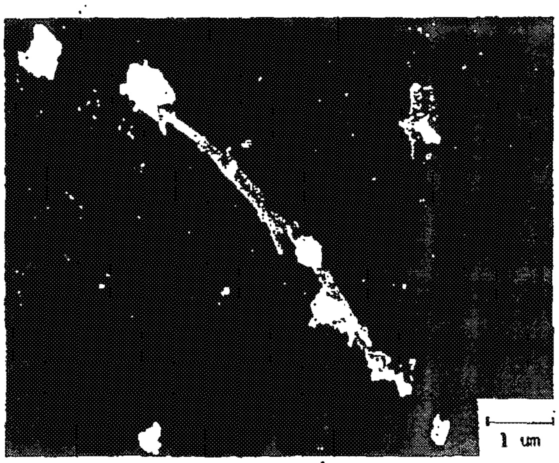

FIGURE 1
Scanning electron microphotograph of typical particulate matter observed from an air sample collected during the beveling of an asbestos-containing friction pad.

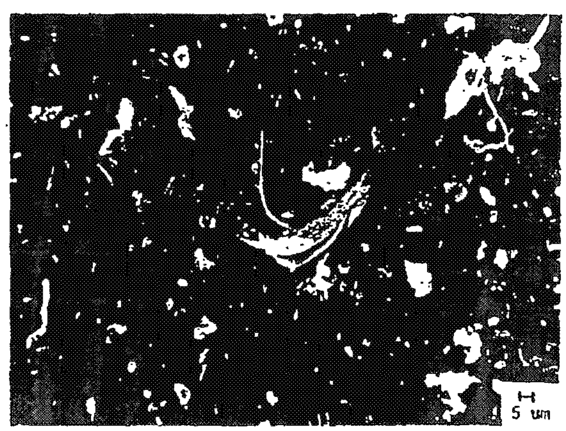

FIGURE 3
Scanning electron microphotograph of a sample of brake residue obtained from drilling an asbestos-containing friction material pad.

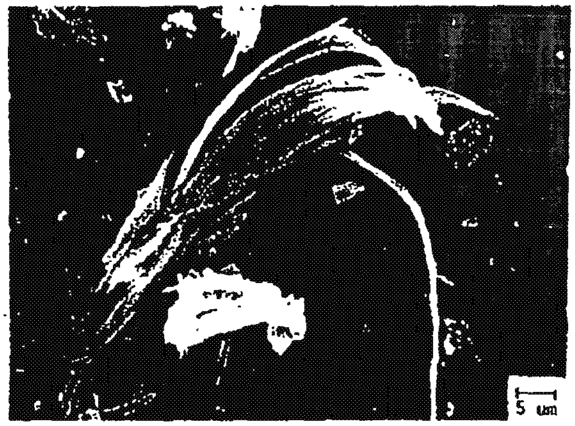

FIGURE 4
Enlargement of scanning electron microphotograph showing the central portion of Figure 3.

Figures 1–4 demonstrate that the majority of fibers collected on filters from the air stream have resin deposits attached. Such fibers would be expected to have aerodynamic characteristics considerably different from "clean" fibers of the same length and diameter. A resin-coated fiber would not be expected to have much opportunity to gain entry into the respiratory system, or, if inhaled, would more likely deposit higher in the respiratory tract where there is limited retention.[17–19]

CONCLUSIONS

The results of this investigation demonstrate that manipulation of asbestos-containing friction products by drilling and grinding of brake pads generates residue containing fibers that, to a great extent, remain bound to the matrix of the underlying brake material. It appears that these procedures are insufficient to release aerodynamically clean fibers from the friction material matrix. These data offer support for a consideration that the processes of grinding and drilling do not pose an important source of exposure to respirable asbestos fibers.

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