A Study Determining Asbestos Fiber Release During the Removal of Valve Packing

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Asbestos packing material used in valves is generally considered to be a nonfriable material unless cut or torn. In a controlled, contained area within a steam power plant, personal and area air samples were collected before and during removal of asbestos packing material from valves that had been used at the plant. The results of this study show asbestos fibers can be released into the air during the generally used procedures for the removal of asbestos packing material. Air concentrations were measured by phase contrast microscopy in the range of 0.2 to 1.3 fibers/cc and by transmission electron microscopy in the range of 1.5 to 4.2 fibers/cc for all diameter fibers greater than 5 μm in length. Millette, J.R.; Mount, M.D.: A Study Determining Asbestos Fiber Release During the Removal of Valve Packing. Appl. Occup. Environ. Hyg. 8(9):790–793; 1993.

Introduction

Most piping systems use valves to regulate the flow of fluids or gases within them. The valves, especially in industrial facilities, may contain asbestos packing material that acts as a seal to prevent fluid or gas leakage as the valve is turned. Periodically, the values must be repaired or routinely maintained by removing the packing and replacing it with new packing. In some steam plants, it is common practice to perform the removal and repacking of a number of valves at one time. This effort may involve several workers and take a number of days to complete. A literature search showed only one published study reporting on the release of asbestos fibers from packing material.[1]

Asbestos Packing Material

According to the U.S. Environmental Protection Agency (EPA), asbestos packing means an asbestos-containing product intended for use as a mechanical seal in circumstances involving rotary, reciprocating, and helical motions, and which are intending to restrict fluid or gas leakage between moving and stationary surfaces.[2] In a valve, the packing is compressed against the bore of the box by a gland that is tightened down on the packing (Figure 1). The packing is forced against the throat of the valve box and the packing conforms to the valve shaft surface, forming a tight seal. Compression packings are manufactured from various types of fibers, such as vegetable, animal, mineral (asbestos) or synthetic, and twisted or braided with binders and lubricants.[3] One of the most commonly used types of compression packing in valves is a graphite impregnated packing material that has the appearance of shiny, stiff rope.

Packings are not considered friable asbestos-containing materials (ACM) because they are not easily crumbled into fine or dusty material by hand pressure. However, the EPA states that products such as packing may release asbestos dust if cut or torn.[4]

Study Design

Asbestos-containing materials are common in industrial steam plants, and because a maintenance activity often involves the disturbance of more than one material, it is difficult to assess the contribution, if any, of a particular ACM to the overall airborne asbestos concentration. Valve packing removal, for instance, may involve the removal or at least disturbance of asbestos-containing pipe insulation or fitting "mud." Therefore, to determine the possible contribution of valve packing only, special precautions were taken to isolate this material from other activities that might have contributed airborne asbestos from other sources.

Study Site

The study was conducted in an unused steam power plant in Manchester, New Hampshire. The study team conducted the valve packing removal tests after an asbestos abatement contractor had prepared a double containment area around two valves attached to the main power plant turbine. Prior to the studies, the abatement contractor prepared the valves by removing all pipe insulation from the valve area and thoroughly cleaning each valve. In a separate area of the plant, the abatement contractor also prepared a third valve that had been disconnected from the steam plant piping system by similarly removing all the pipe insu-

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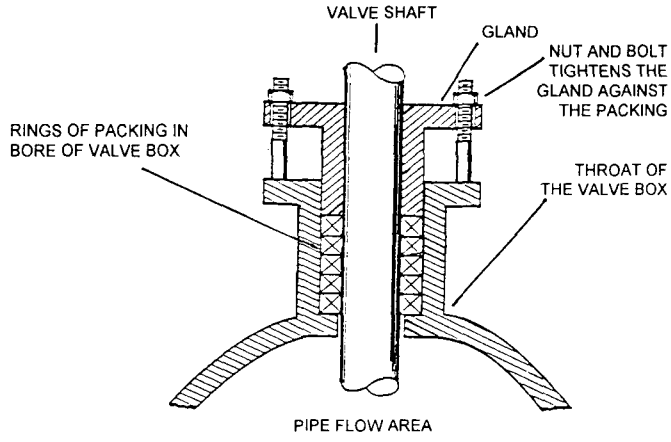

FIGURE 1. Diagram of steam pipe valve containing packing.

lation and cleaning the valve thoroughly. This valve was later moved into the containment for packing removal. The containment barriers in the area consisted of layers of polyethylene plastic sheets on a wooden frame and 2 layers of polyethylene plastic on the floor. A containment area (5 × 7 ft) around the valves was completely contained within a larger containment area (7½ × 11 ft) (Figure 2). The study area had two high efficiency particulate absolute air filtration devices (AFD) used to clean the air of particulate including asbestos before each valve packing removal activity. The inner area AFD was turned off during each phase of testing. The outer area AFD operated throughout the tests.

Study Procedures

The study consisted of the collection of air samples before and during valve packing removal activities. A retired steam plant maintenance worker/supervisor using his own tools performed the valve packing removal in the same way that he had in his previous years of work on industrial valves and as is often done in power plants today. Although some lubricating oil was used to loosen the packing, the work was generally done in a dry manner. Three packing removal tests were performed. The first two packing removal activities consisted of opening valves connected to 4- to 6-inch diameter pipes and reaching in with a variety of tools to pull out three to four rings of the old packing. The third test utilized the same valve that had been opened in the second test and duplicated the packing removal activity. More packing was removed under the same conditions as the second test. Pieces of the removed packing were placed in plastic bags and stored for analysis. The packing removed from both valves appeared to be graphite impregnated packing material that had a shiny gray-black appearance. Each packing removal activity occurred for approximately 30 minutes. The study site was cleaned between activities.

Prior to starting each part of the study, four area air samples were collected to determine the background level of asbestos in the air of the study area. The sampling cassettes were located on the walls at the breathing zone, 5 feet from the floor. A volume of 720 to 840 L of air was passed through each cassette at a flow rate of 15 L/min. Two area air samples

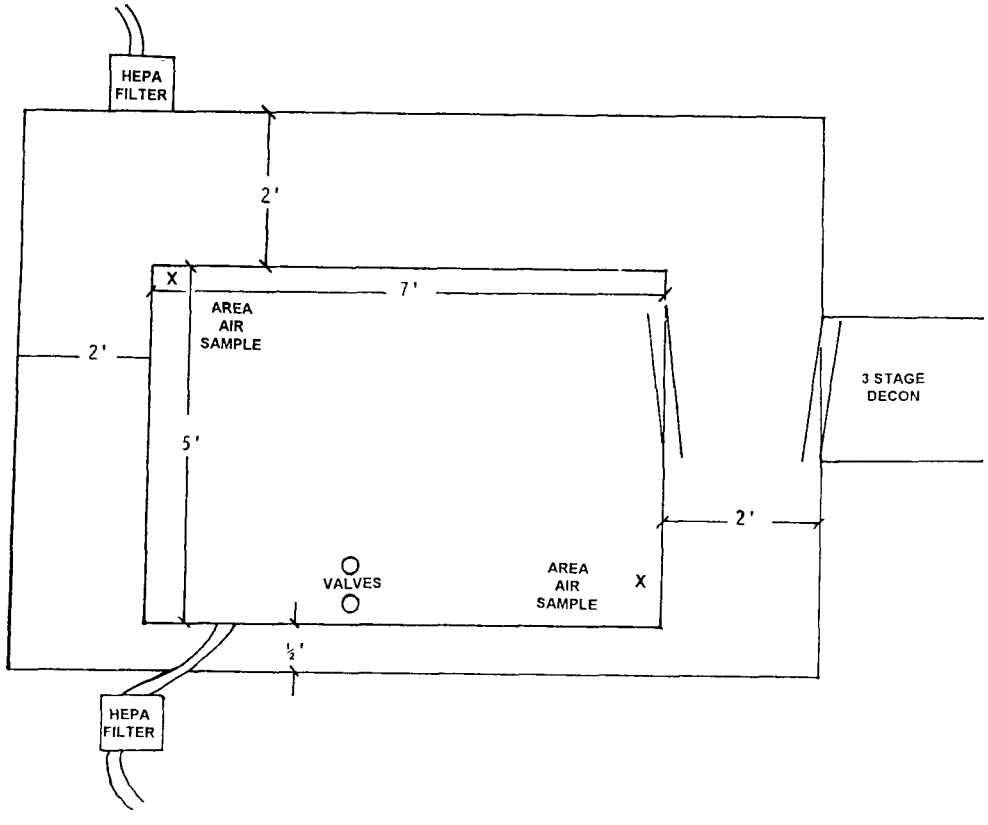

FIGURE 2. Diagram of enclosure for valve packing removal study.

were collected during the valve packing removal in the same locations as two of the background air samples, approximately 5 feet from the gasket removal activity. One was collected at 7.5 L/min; the other at 15 L/min. The person doing the packing removal was fitted with two personal air sampling devices as was a person observing and photographing the activity. These personal air samples were collected at rates from 2 to 3.5 L/min.

All personnel inside the study area were protected by air purifying respirators and complete head and body coverings. The decontamination system consisted of a changing room outside the testing area, a shower room and a clean suit-up room. The decontamination system was used each time a person exited the study area and the overall containment area.

Analytical Methods

Air samples were analyzed by the standard phase contrast microscopy (PCM) method[5] using the "A" counting rules.

Although the phase contrast microscope enhances the analyst's ability to see fibers over other types of light microscopes, the standard procedure does not involve identification steps that specifically determine how many of the fibers counted are actually asbestos. Because packing material is known to contain other types of fibers, some of the samples were analyzed by transmission electron microscopy (TEM) following the NIOSH 7402 preparation procedure.[6] The TEM analysis method identifies asbestos fibers on the basis of morphology, crystal structure and X-ray elemental analysis. Although many shorter fibers were seen, only asbestos fibers longer than 5 μm were counted.

Polarized light microscopy was used to determine the type of asbestos in the samples of packing material removed from the valves. A friability test was performed on samples of packing material that had been removed from valves as well as on some unused asbestos packing material found in a storeroom at the steam plant.

The friability test to determine whether or not an asbestos-containing material will potentially release asbestos is a field test in which an attempt is made to crumble the ACM by hand. If the material can be crumbled by hand, it is considered friable. The EPA distinguishes friable from nonfriable ACM in their regulations on handling asbestos products. Friable ACM is considered more of a potential hazard than nonfriable material.

Results

The results of the air monitoring are shown in Table I. During the second valve packing removal activity, which lasted approximately one-half hour, the asbestos fiber level for the person removing the packing was in the range of 1 fiber/cc, the Occupational Safety and Health Administration excursion level. Personal samples on the person nearby the packing remover collected over periods from 25 to 40 minutes were over 0.1 fiber/cc. The area samples collected

TABLE I. Results of Air Monitoring Prior to and During Asbestos Packing Removal

Sample Description	Sample Duration (min)	Air Volume (L)	Concentration (fibers/cc)
Test 1			
Area before packing removal	54	810	0.006[A]
Area before packing removal	56	840	0.006[A]
Area before packing removal	56	840	0.006[A]
Area before packing removal	56	840	0.006[A]
Personal packing remover	25	50	0.2
Personal packing remover	Pump failure		NA
Personal observer	25	87.5	0.1 (0.1)[B]
Personal observer	25	50	0.2
Area during packing removal	26	390	0.06
Area during packing removal	Filter damage		NA
Test 2			
Area before packing removal	57	855	0.006[A]
Area before packing removal	56	840	0.009
Area before packing removal	56	840	0.006[A]
Area before packing removal	56	840	0.006[A]
Personal packing remover	31	93	1.0
Personal packing remover	31	62	1.3
Personal observer	31	62	0.9
Personal observer	31	93	0.6 (0.5)[B]
Area during packing removal	24	180	0.4
Area during packing removal	25	375	0.3
Test 3			
Area before packing removal	48	720	0.007[A]
Area before packing removal	48	720	0.007[A]
Area before packing removal	48	720	0.007[A]
Area before packing removal	48	720	0.007[A]
Personal packing remover	33	66	0.4 (0.5)[B]
Personal packing remover	33	99	0.7 (0.7)[B]
Personal observer	39	117	0.2
Personal observer	39	78	0.2 (0.4)[B]
Area during packing removal	35	525	0.2
Area during packing removal	35	262.5	0.2

[A]At detection limit.
[B]Quality control by second analyst.
NA = not available.

in the vicinity of the packing removal activity were elevated over the background levels in all three tests.

The TEM analysis results are shown in Table II. Only asbestos fibers longer than 5.0 μm were recorded. Chrysotile fibers were identified as the primary type of fiber. It is generally considered that fibers thinner than 0.25 μm would not be resolved by the light microscope used in the PCM method. Therefore, two TEM asbestos concentrations are listed. One of all asbestos fibers greater than 5 μm, and one which includes only those fibers over 5 μm in length and also greater than 0.25 μm in width. The latter value is considered a PCM equivalent count because these fibers counted in the TEM should be roughly equivalent to what would be counted under the PCM.

The used packing, removed from the valve, was friable. Polarized light microscopic analysis showed it to be approximately 85 percent chrysotile, while the bulk of the re-

TABLE II. Transmission Electron Microscopy Results on Personal Air Monitoring Samples During Packing Removal

Sample Description	Asbestos Concentration (fibers/cc) All > 5μm	PCM Equivalent*
Test 2		
Personal packing remover	2.2	1.5
Personal packing remover	4.2	2.6
Test 3		
Personal packing remover	1.5	1.2
Personal packing remover	2.1	1.5

*Phase contrast microscopy equivalent by transmission electron microscopy counting. Asbestos fibers or bundles greater than or equal to 5μm in length and at least 0.25 μm in width (3:1 aspect ratio).

maining material was carbon. Similar looking unused asbestos packing found in the storeroom of the power plant was not friable. In an additional test, a piece of the unused packing was subjected to heating at 400°C for 1 hour in a muffle furnace. The packing became friable after the treatment by heat.

Conclusions

Asbestos packing, although not friable in original, unused condition, can become friable after use in valves and can release asbestos fibers into the air during valve packing removal operations. The levels of asbestos detected in the air were similar to the levels reported previously for valve packing activities[1] and in some instances involving gasket removal activities.[7]

Recommendations

The results of these tests suggest that asbestos packing material, although not identified as a friable ACM, should be considered as such during packing removal activities. If possible, the packing should be wetted with water or oil before it is cut and torn with packing tools such as hooks during the procedures for removing old packing.

References

1. McKinnery, W.N.; Moore, R.W.: Evaluation of Airborne Asbestos Fiber Levels During Removal and Installation of Valve Gaskets and Packing. Am. Ind. Hyg. Assoc. J. 53(8):531–532 (1992).
2. U.S. Environmental Protection Agency: Title 40, Code of Federal Regulations, Part 763. Asbestos: Manufacture, Importation, Processing and Distribution in Commerce Prohibitions; Final Rule. Fed. Reg. 54(132)(July 12, 1989).
3. Nelson, C.A.: Millwrights and Mechanics Guide, p. 236. McMillan Publishing Co., London (1986).
4. U.S. Environmental Protection Agency: Asbestos Waste Management Guidance. EPA-530/SW-85-007. Office of Solid Waste, Washington, DC (May 1985).
5. Carter, J.W.; Taylor, D.G.; Baron, P.A.: Method 7400. In: NIOSH Manual of Analytical Methods, p. 7400-1–7400-8. National Institute for Occupational Safety and Health, Cincinnati, OH (1984).
6. Carter, J.W.; Baron, P.A.; Taylor, D.G.: Method 7402. In: NIOSH Manual of Analytical Methods, p. 7402-1–7402-7. National Institute for Occupational Safety and Health, Cincinnati, OH (1987).
7. Cheng, R.T.; McDermott, H.J.: Exposure to Asbestos from Asbestos Gaskets. Appl. Occup. Environ. Hyg. 6:588–591 (1991).

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