1999

Report for MVA Project No. 0765
Asbestos Fiber Release
During the Removal of a Sheet Gasket

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Abstract

Asbestos sheet gasket material used between piping flanges is generally considered to be a non-friable material unless cut or torn. In a controlled area, personal and area air samples were collected before and during the removal of asbestos sheet gasket material and wire-brushing of the pipe flange. The results of this study show asbestos fibers can be released into the air during the procedures for the removal of asbestos sheet gasket material and wire-brushing of the flange. Cleaning of the area with a broom after removal also increased airborne fiber concentrations. Air concentrations were measured by phase contrast microscopy to be from 0.1 to 6 fibers/cc and by transmission electron microscopy in the range of 3.9 to 62 fibers/cc for asbestos fibers of all sizes.

Introduction

Most piping systems, especially in industrial and maritime facilities, use gaskets to seal joints. The gaskets may contain asbestos fibers as part of their composition. Periodically, a pipe connection must be broken at the flanges and the old gasket removed. This effort may require a simple scraping with hand tools or may need the assistance of power tools to clean-up the flange.

Asbestos Sheet Gasket Material

According to the U.S. Environmental Protection Agency (EPA), gaskets are materials used to seal one compartment of a device from another in applications such as engine and exhaust manifolds. Asbestos gaskets are used mainly to seal connections and prevent leakage of fluids between solid surfaces. Gaskets, often consisting of more than 70% chrysotile asbestos, are used against alkaline, neutral or weak acid solutions. Crocidolite containing gaskets have been used against harsher acid solutions. Sheet gaskets are composed of chrysotile asbestos compressed into a

sheet with styrene butadiene rubber or other binder. Other organic binders used in making asbestos gaskets include natural rubber, buna-S and buna-N synthetic rubbers, or neoprene.

Study Design

Asbestos-containing materials are common in industrial sites and on ships 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. To determine the possible contribution of an asbestos gasket only during removal, special precautions were taken to isolate the removal activity from other activities that might have contributed airborne asbestos from other sources.

Study Site

The study was conducted in a warehouse in Norcross, Georgia. An asbestos abatement type enclosure was built for the study to isolate the testing from any other source of asbestos and to prevent any fiber release from contaminating the building. The containment barriers in the area consisted of three layers of 6-mil polyethylene plastic sheets on a wooden frame and three layers of 6-mil polyethylene plastic on the floor. The containment area (8 ft by 8 ft) was completely contained within a larger containment area. The study area had a two High Efficiency Particulate Absolute (HEPA) air filtration device (AFD) used to clean the area of particulate including asbestos before the gasket removal activity. In the outer area the AFD operated throughout the test.

Study Procedures

The study consisted of the collection of air samples before, during, and after a gasket removal activity. A valve that had been used in a steam line onboard a ship was used for the experiment. The valve assembly had two sets of flanges with a gasket between each set of flanges. According to the retired steamfitter performing the gasket removal the valve assembly probably carried 40 to 75 pound steam through it. The temperature in the valve could have reached about 300° F. Gaskets were removed from both sides of the valve.

The removal was separated into two activities with separate air samples being collected during each activity. The flanges were first scraped with a putty knife or screw driver to remove the majority of the gasket material. The flanges were then wire brushed with an air powered drill to remove the residual gasket material adhering to the flanges. The drill was a Campbell Hausfeld Model TL1006 drill that has a maximum speed rating of 2500 RPMs.

Prior to starting the study, three (3) area air samples were collected to determine the background level of asbestos in the air of the study area using aggressive sampling and operating the drill for approximately two minutes before starting the air samples. The sampling cassettes were located on the walls at the breathing zone, five feet from the floor. Area air samples were collected during the sheet gasket removal in the same locations as each of the background air samples, approximately five feet from the gasket removal activity. The person doing the gasket removal was fitted with two personal air sampling devices.

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, 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 NIOSH 7400 using the "A" counting rules.

Although the phase contract microscope enhances the analyst's ability to see fibers over other types of light microscopes, the standard procedure involves does not involve identification steps which specifically determine how many of the fibers counted are actually asbestos. Because sheet gasket material is known to contain other types of fibers, some of the samples were prepared for further study by transmission electron microscopy (TEM). The samples were prepared and analyzed using the International Standards Organization (ISO) Direct preparation counting procedure. This TEM analysis method identifies asbestos fibers on the basis of morphology, crystal structure

and x-ray elemental analysis. On one sample during each activity, all asbestos fibers longer than 0.5 µm were counted by TEM so that a total asbestos concentration could be determined. In other samples only those fibers longer than 5 µm and wider than 0.25 µm were counted to provide an asbestos count equivalent to the PCM data.

Polarized light microscopy (PLM) was used to determine the type of asbestos in the sheet gasket material. A friability test was performed on the samples of gasket material removed from the flanges. The EPA friability test is a field test in which an attempt is made to crumble the ACM by hand. If the material produces dust when crumbled by hand, it is considered friable. The EPA distinquishes friable from non-friable ACM in their regulations on handling asbestos products. Friable ACM is considered more of a potential hazard than non-friable material.

Results

The results of the air monitoring are shown in Table 1. During the sheet gasket removal activity, which lasted approximately 34 minutes, the asbestos fiber level for the person removing the packing was 1.86 fibers/cc (PCM) time weighted for the period of removal. It should be noted that only fibers greater than 5.0 µm are counted using the PCM method. The area samples collected in the vicinity of the sheet gasket cutting activity showed levels of fibers elevated over the background levels. The TEM analysis results are also shown in Table 1. Chrysotile fibers were identified as the primary type of fiber. The TEM fiber counts ranged from 3.9 to 62 fibers per cc for asbestos fibers of all sizes above 0.5 µm in length. A list of flow rates and air volumes for the cassettes is given in Table 2.

Polarized light microscopic analysis showed the sheet gasket to be approximately 80% chrysotile (Appendix C).

The gasket materials removed from the valve flanges were dry and friable.

Conclusions

Asbestos sheet gasket, although not considered friable in original, unused condition, can release asbestos fibers into the air during removal operations both when

hand methods are used and when air-powered wire-brushing is done. Clean-up following the removal may resuspend dust containing asbestos into the air .

Recommendations

The results of these tests suggest that asbestos sheet gasket material, although not considered as a friable ACM when new, should be considered as such during removal activities, especially if a powered brushing device is involved.

Table 1

Summary of Air Sampling Results
for Gasket Removal

MVA, Inc.
5500 Oakbrook Parkway, Suite 200
Norcross, GA 30093
(404) 662-8509

Activity	Min	PCM* (f/cc)	TEM** (s/cc)
Background	157	0.004	<0.02
Hand Scraping	16	0.14	3.9
Power Wire Brushing	4	6.8	62
Hand Scraping and Power Wire Brushing	14 –	2.1	20
Broom Sweeping of Area After Removal	5 –	5.5	44
Total	19 –	~~2.9~~ 3.0	
	for 30 min =	1.9	

* Phase Contrast Microscopy counts fibers greater than 5 µm in length and greater than 0.25 µm in diameter.

** Transmission Electron Microscopy identifies and counts asbestos fibers greater than 0.5 µm in length and greater than 0.02 µm in diameter.

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Table 2
Summary of Results -- PCM Data
MVA, Inc.
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Norcross, GA 30093
(404) 662-8509

Project Name: Gaskel Removal Experiment Project No.: 0765

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Sample No.	Date	Sample Location/ Description	Average Flow (L/Min)	Duration (Min)	Volume (L)	Fibers Counted	Fielc Count
1 - D4037	12/29/93	Background; in NW corner of work area	9.8	157	1539	19.5	100
2 - D4038	12/29/93	Background; in NE corner of work area	9.8	157	1539	12	100
3 - D4039	12/29/93	Background; in SE corner of work area	9.8	157	1539	23	100
4 - D4040	12/29/93	Area; in center of work area; during scrape	0.9	16	14.4	3	100
5 - D4041	12/29/93	Personal; left side; during scrape	1.2	16	19.2	8.5	100
6 - D4042	12/29/93	Personal; right side; during scrape	1.2	16	19.2	7.5	100

*The average value of the two blank samples (2 fibers/100 fields) was subtracted from the total fiber count for calculation o

+The number of fibers counted in sample no. 4 was less than the estimated limit of detection (LOD) for the method, which i airborne fiber concentration is calculated using the LOD; thus the reported value should be considered higher than the true

IWA = Inside Work Area OWA = Outside Work Area O.L. = Over Loaded D = Damaged PF = Pump Failure NA = Nc

Table 2
Summary of Results – PCM Data
MVA, Inc.
6500 Oakbrook Parkway, Suite 200
Norcross, GA 30093
(404) 662-8509

Project Name: Gaskel Removal Experiment Project No.: 0765

Sample No.	Date	Sample Location/ Description	Average Flow (L/Min)	Duration (Min)	Volume (L)	Fibers Counted	Me Fl Re Fiel Cour
7 - D4043	12/29/93	Area; In center of work area; during wire brush	0.9	12	10.8	101.5	10(
8 - D4044	12/29/93	Personal; left side; during wire brush	1.2	4	4.8	76	10(
9 - D4045	12/29/93	Personal; right side; during wire brush	1.2	4	4.8	70.5	10(
10 - D4046	12/29/93	Personal; left side; during scrape and wire brush	1.2	14	16.8	89.5	10(
11 - D4047	12/29/93	Personal; right side; during scrape and wire brush	1.2	14	16.8	68	10(
12 - D4048	12/29/93	Area; NW corner of work area; during scrape and wire brush	5	37	185	73	10(
13 - D4049	12/29/93	Area; NE corner of work area; during scrape and wire brush	5	32	160	67.5	10(

*The average value of the two blank samples (2 fibers/100 fields) was subtracted from the total fiber count for calculation

**Samples 7, 8 and 10 through 14 are heavily loaded with particulate which could result in the lack of detection of fibers.

IWA = Inside Work Area OWA = Outside Work Area O.L. = Over Loaded D = Damaged PF = Pump Failure NA = N

D:PROJECTS:0765:RPT0127

Table 2
Summary of Results – PCM Data
MVA, Inc.
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Project Name: Gasket Removal Experiment Project No.: 0765

Sample No.	Date	Sample Location/ Description	Average Flow (L/Min)	Duration (Min)	Volume (L)	Fibers Counted	Fiel Coun
14 - D4050	12/29/93	Area; on south center wall; during scrape and wire brush	5	37	185	51.5	100
15 - D4051	12/29/93	Area; center of work area; during sweeping	0.9	5	4.5	78.5	100
16 - D4052	12/29/93	Personal; left side; during sweeping	1.2	5	6	73.5	100
17 - D4053	12/29/93	Personal; right side; during sweeping	1.2	5	8	75	100
18 - D4058	12/29/93	Blank, field	NA	NA	NA	3.5	100
19 - D4059	12/29/93	Blank, sealed	NA	NA	NA	0.5	100

*The average value of the two blank samples (2 fibers/100 fields) was subtracted from the total fiber count for calculation o

**Samples 7, 8 and 10 through 14 are heavily loaded with particulate which could result in the lack of detection of fibers.

IWA = Inside Work Area OWA = Outside Work Area O.L. = Over Loaded D = Damaged PF = Pump Failure NA = N

D:PROJECTS:0765:RPT0127

MAS

Spiral Wound Gasket Removal

Work Practice Study

Materials Analytical Services, Inc.
June, 2000

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Spiral Wound Gasket Removal

Work Practice Study

1 Study, Design & Protocol

2 Summary of Data

PCM, TEM, & Fabric Analysis

3 Bulk Sample Analysis & Affidavit

1. M23793

4 Air Sample Analysis

1. M23791

5 Fabric Analysis Results

1. M23792

6 Tools Used in Study

7 Photographs

8

Spiral Wound Gasket Removal Work Practice Study

This study was designed and conducted by Richard Hatfield, William Longo, Ph.D., and Larry R. Newton, CIH, CSP.

Study Design and Methodology

The study was performed in the exposure characterization lab (ECL). The size of the ECL is approximately 20 ft x 15 ft x 8 ft and the walls and ceiling is constructed of a painted plastic laminate. The ECL is constructed with two viewing windows for video taping purposes and has a ventilation rate of approximately 200 cubic feet per minute with two primary inlet sources and a negative air machine that produces a constant airflow during the study.

During video taping of the work practice study, lighting is utilized inside the ECL to increase the possible observations of dust release during the work practice. Previous studies have shown that the use of, what is commonly referred to as the "Tyndall light phenomena", is an effective method of displaying respirable airborne dust generated from workplace activities.[1,2,3,4] To minimize light reflection, the walls, floor and ceiling inside the ECL are painted black.

MAS received a number of flanges and valves from Dr. Robert Gay. Dr. Gay had harvested these flanges and valves from a wood products mill powerhouse located in Oregon. Three of these valve and flange assemblies which contained spiral wound gaskets were selected. A fourth valve and flange assembly was provided by Patton, Warnom, & Watkins. The four flange assemblies were identified as containing spiral wound gaskets and were partially opened to confirm the presence of these asbestos containing gaskets prior to the work practice study. The flanges were reassembled and the outside surfaces were cleaned. After cleaning, the flange assemblies were sand blasted and painted. The cleaning and painting measures were performed to eliminate any contribution of asbestos from previous thermal insulation, which may have been present. Four flange assemblies were slated for use in this study. Each assembly contained two flanges; therefore, eight spiral wound gaskets were to be removed in this study.

During the study, air samples were collected using 25 mm cassettes containing 0.8-micron pore size mixed cellulose ester (MCE) filter on a 5.0 micron backing pad. The air sampling pumps were calibrated both before and after the sample collection. High volume pumps were used for area air samples during the simulation. The pumps were located outside the ECL and connected to the air samples cassettes by Tygon® tubing through the walls of the ECL.

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[1] Surgen Commander P.G. Harris, "The Effects and Control of Disease Associated with Exposure in Devonport Dockyard," Doctoral Dissertation.
[2] C. Dernchl & K.S. Lane, "Asbestos Toxicology Report," Union Carbide Corporation.
[3] D.T. ECL's "Dust Control Development" (S. Chissick & R. Derricott), in Asbestos, Volume 2, Properties, Applications and Hazards, 6, 193, 1983.
[4] I. J. Selikoff, "Insulation Hygiene Progress Report," Volume 3, No. 4, Winter, 1971.

The four area air samples were located around the work site. The area air sampling cassettes were placed approximately five feet from the floor and 6 to 7 feet from the work activity. The high volume pumps were calibrated to a flow rate of 10 liters per minute for both background and area samples collected during the study. The two investigators performing the work practice were each fitted with two personnel air sampling pumps with connecting tubing and 25 mm MCE air sampling cassettes. The air sampling cassettes were attached to each shoulder and within the breathing zone of each investigator. The personnel air sampling pumps were calibrated to a flow rate of 2 liters per minute. Before working on the flanges, background samples were run inside and outside the ECL. The air samples were collected in general accordance with NIOSH Method 7400 for measuring airborne asbestos fibers.

The individuals working inside the ECL wore Tyvek® suits under cotton/polyester (35% / 65%) work clothes, and were supplied air through full-face pressure demand respirators equipped with an escape HEPA filter system. The ECL design included a decontamination area for clothing removal and a shower to remove residual asbestos contamination before the individuals left the ECL area.

Gasket Removal and Electric Wire Brushing

Four flange assemblies were used for this study for a total of eight spiral wound gaskets to be removed. During the study, the flange face was opened and the spiral wound gasket was removed. In most cases, the spiral wound gasket assembly was easily removed from the flange face; however, it was observed that the spiral wound gasket assembly would generally leave a small amount of gasket residue on the flange surface. This residue was removed by using an electric wire brush as described by former machinist and maintenance personnel.

Analytical Methods

All air sample cassette filters were analyzed by NIOSH Method 7400 PCM method using A counting rules. A portion of the filter material from the air samples was analyzed by TEM using the indirect method after preparation by the ASTM D5755-95 analytical protocol.

The spiral wound gaskets were collected from the four flange assemblies that were removed during the study. These eight samples were analyzed by PLM to determine the asbestos content. Additionally, an effort was made to identify the manufacturer of the spiral wound gaskets.

Results

During the work practice, the worker was exposed to levels of airborne asbestos fibers between 1.1 to 1.4 fibers/cc as measured by PCM and between 76.5 to 402.2 structures/cc as measured by TEM. The helper/assistant's exposure level ranged from 1.0 to 1.2 fibers/cc as measured by PCM and between 7.7 to 50.1 structures/cc as measured by TEM. The

clothing worn by the worker was contaminated with respirable asbestos fibers. The one fabric sample tested, resulted in a level of 131.7 million asbestos structures per square foot.

The PLM analysis showed that each of the spiral wound gaskets contained approximately 60% chrysotile asbestos. Four of the gaskets were identified to be manufacturered by Flexitallic and four were manufactured by Parker.

Conclusion

MAS conducted a study to determine if there were any asbestos exposures to asbestos fibers generated by removing and electric wire brushing of spiral wound asbestos containing gasket material from flanges. Typically, a maintenance operation will first remove the spiral wound gasket from the flange, and then polish the flange face with either a pneumatic or electric rotary drill brush equipped with a wire wheel.

These results show that employees should wear at a minimum, powered air purified respirators (PAPR) to conduct this operation. In addition, an employee standing near the work activity will also be exposed to significant levels of asbestos fibers. This employee will require the same level of respiratory protection. The results show that both the employee and the helper brushing the gasket exceeded OSHA's current asbestos excursion limit of 1 fiber/cc throughout the study. This work should also be performed in an enclosed room or glove bagged to prevent asbestos fibers from migrating and exposing other personnel.

On examination of the PCM filters, it was observed that all filters taken during the study were overloaded with non-asbestos particulate. This type of overloading, will bias the fiber counts to lower concentrations. Therefore, the PCM fiber counts can only be considered as a minimum exposure. The evidence that the PCM counts should have been higher lies in the TEM data. Based on the fibers >5µm in length and greater than 0.25µm in diameter counted in the TEM analyses, the PCM counts should have been as much as four to five times higher.

SPIRAL WOUND GASKET REMOVAL

Work Practice Simulation
June 2, 2000

Protocol

Richard Hatfield, William E. Longo, Ph.D., Larry Newton, CIH, CSP

I. ECL SET-UP

A. Study is to be performed in the exposure characterization lab (ECL) constructed using negative airflow asbestos abatement technology. The size of the ECL is approximately 15' x 20' x 8'.

B. Air exchange inside the ECL will be approximately 200 cubic feet per minute as measured (Extech Model 451126) at the air exhaust of the HEPA filter negative air machine (Aramsco, Comanche Model #55011).

C. Tyndall lighting setup according to the protocol as described in D.T. Chambers, "Asbestos", John Wiley & Sons, 6, 193, 1979.

II. BACKGROUND AIR SAMPLES

A. Adjust and calibrate high volume area pumps to 10 liters per minute.

B. Setup four area air samples inside the ECL. Use 25 mm air cassettes Containing 0.8 micron pore size mixed cellulose ester (MCE) filters with a 5.0 micron backing pad.

C. Locate the area air samples in each quadrant of the ECL at a height of 55" from the floor and a distance of approximately 6 feet from the work activity.

III. WORK PRACTICE STUDY

Four flange assemblies will be utilized in this study. On each assembly, there are two flanges; therefore, eight spiral wound gaskets will be removed in the study. The method used will be to first remove the gasket assembly then electric wire brush to remove any residue and polish the flange facings.

A. During this study, the area samples will be calibrated and run at a rate of 10 liters/minute.

B. The worker and observer/assistant will each be fitted with two personnel air pumps and air cassettes located in their breathing zone and calibrated

at a flow rate of 2 liters/minute.

C. Both the worker and the observer/assistant will wear appropriate protective clothing, work apparel and appropriate respiratory protection equipment.

D. The work practice will be performed under both ambient and Tyndall lighting.

E. The entire procedure will be videotaped with three separate cameras. During filming, the Tyndall lighting will be turned off and overhead lights turned on at least once during the study.

F. Air samples for both the area and personnel will be collected during the entire duration of the study.

IV. LABORATORY ANALYSIS

A. All air samples will be analyzed by the NIOSH 7400 PCM method using A counting rules and by TEM analysis.

B. For the TEM analysis, all samples will be analyzed by the indirect method. Samples will be prepared using the ASTM D5755-95 method protocol.

C. Fabric samples will be analyzed by the Chatfield method.

MATERIALS ANALYTICAL SERVICES, INC.

Work Practice Simulation Protocol

I) Chamber Setup

A) The walls, ceiling, and floor are painted black to diminish light reflection.
B) Arranged lighting for Tyndall effect in general accordance with the method described in by D.T. Chambers, "Asbestos", John Wiley & Sons, 6, 193, 1979.

II) Background Air Samples

A) Adjust and calibrate high volume area pump to appropriate flow rate.
B) Set up two or more air samples inside the chamber and one outside air sample in general accordance with the procedure outlined in the NIOSH 7400 method.

III) Work Practice Study[1]

A) Review the appropriate information on work practices simulation.
B) Acquire all necessary tools and materials required for work practice simulation.
C) Calibrate personnel and high volume sampling pumps appropriate to flow rates.
D) Set ventilation to 200 cubic feet per minute as measured with the Extech Flow Anemometer.
E) Set up two or more inside air samples and one outside air sample in general accordance with the procedure outlined in the NIOSH 7400 Method.
F) Participants in the study are to wear protective clothing, work apparel, and respiratory protection equipment.
G) Set up the personnel air samples in general accordance with the procedure outlined in the NIOSH 7400 method.
H) Determine the appropriate time for the length of study.
I) Work practice study performed as determined in Section III, A&B.

[1] Parts of the procedure may be done in advance of chamber set up.