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A METHOD FOR THE DETERMINATION OF FIBER EMISSIONS FROM SOUND ABSORBENT MATERIALS

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ABSTRACT

To evaluate the health risk posed by particles emitted from sound absorbent materials used in ventilation channels, the number, size, shape and composition of fibers and other particles must be characterized. A method of studying those particle characteristics has been developed. The number concentration of small particles in the testing chamber was measured with a condensation nucleus counter. Both scanning electron microscopical and optical microscopical analyses were possible for filter samples because of the low particle concentration of background particles in the testing chamber. Some sound absorbent material tests indicated that the airborne fiber levels of the materials were very low in comparison with hygiene limits.

INTRODUCTION

MMMF (man made mineral fiber) materials are used as sound absorbent materials in officies and ventilation channels. The particulate emissions from ventilation channels can follow the air streams to indoor air, posing a potential health risk for the people living in the room. The number, size, shape and composition of fibers and other particles emitted from these materials must be determined in order to assess the potential health risk (1,2,3,4). A method of studying the above-mentioned particle characteristics has been developed.

METHODS

Sound absorbent materials are studied in the testing chamber presented in Fig. 1, in which an air stream flows along the surface of the absorbent material at a velocity of up to 10 m/s. The testing chamber was constructed in a clean air room with a low particle concentration. The clean air room is classified 100 according to the Federal Standard No. 209B (5). The concentration (number per cubic centimetre) of small particles in the testing chamber during the study was measured with a condensation nucleus counter (TSI Model 3760). Particles emitted from the material under study were collected on polycarbonate filters and analyzed with scanning electron microscopy (SEM) and on filters of mixed cellulose esters for optical microscopy. The experimental set-up is presented in Fig. 2.

The filter samples for the optical microscopy were prepared and the fibers were counted using the NIOSH Method 7400/5/17/89. The pieces of the polycarbonate filters were mounted for the SEM studies on brass speciment holders. The samples were carbon-coated for EDS-analysis and later covered with gold for photographing of the particles. The samples were studied with a magnification of 500x and photographed with a magnification of 2700x.

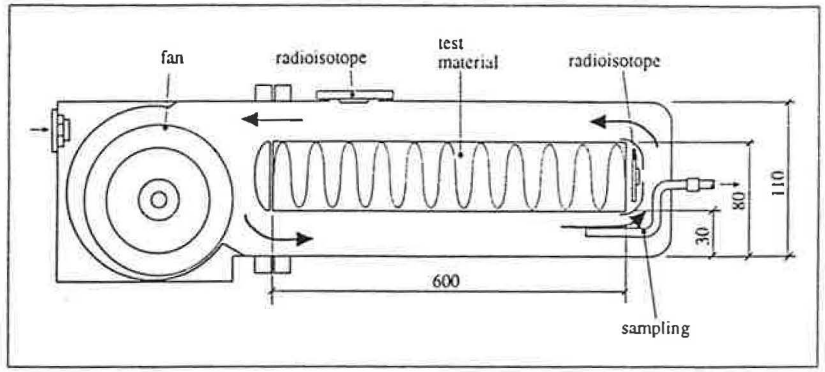

Fig. 1. The chamber, in which the air stream flows along the surface of the test material.

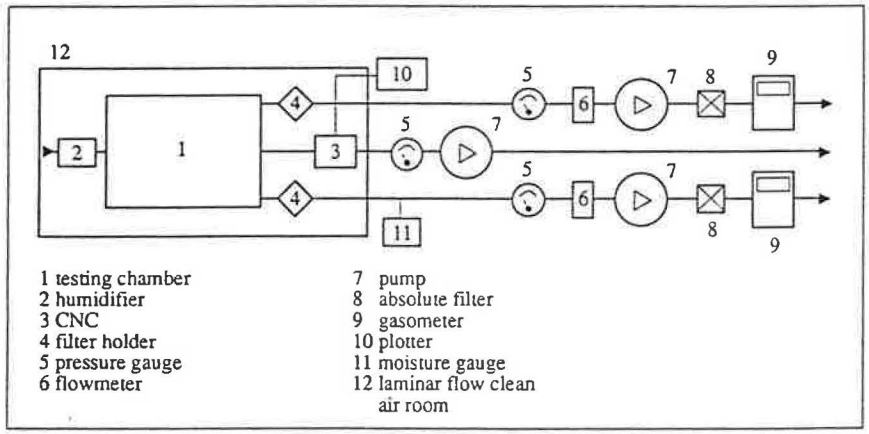

Fig. 2. The experimental set-up for the determination of fiber emissions from sound abosorbent materials.

RESULTS

The testing chamber was characterized using flow velocities of 0 - 10 m/s along the material. The results of testing three different kinds of glass wool material and five rock wool materials with a flow velocity of 7-8 m/s are shown in Table 1. New materials, measuring 590 mm x 190 mm, were studied for a period of at least twenty-four hours after unpacking and light vacuuming. Materials B, E, F and G were covered with a specific surface (P) by the manufacturer. Materials B, D, E, F and H were coverd with a steel screen (V) during some tests. Materials B, E, F and H were wetted and dried (K) before some other tests.

Particles with an aspect ratio of 3:1 were counted as fibers. The background fiber concentration was determined with blanco material (aluminium) as 3 x 10^{-6} fibers/cm^3. The fibers emitted from the test materials were long (30 - 1100 µm) and their concentrations were low (less than 30 x 10^{-6} fibers/cm^3) but obviously exceeded the background concentration. The results in Fig. 3 and 4 show that the size of fibers emitted from the glass wool materials differed from the size of the fibers emitted from rock wool materials in different conditions (moisture/dry materials with different surfaces with and without the steel screen covering). In the SEM analyses, no fibers were found in the samples, but a few mainly silicon-containing particles (in the size range of 1 - 10 µm) with variable amounts of sodium, aluminium and potassium were detected. More particles were found in samples C, D, E, FP, FP(V) and G than in samples FP(K), FP(K,V) and H. This was also seen in the particle concentration determined by the CNC.

Table 1. The results of testing three different kinds of glass wool material (a) and five rock wool materials (b) with a flow velocity of 7-8 m/s in the chamber presented in Fig. 1. Codes: A-H: material code, P: material covered with a specific surface by the manufacturer, V: material covered with a steel screen, K: material wetted and dried before tests.

a) glass wool

Material	Optical microscopy		CNC particle concentration (x 10^{-3}/cm^3)
	Total sample flow (m^3)	Fibers (x 10^{-6}/cm^3)	
A[1]	7.05	7	800-900
A[1]	6.37	13	700-800
D	7.73	5	170-230
D	7.84	3	100-180
D(V)[2]	5.88	14	220-280
D(V)[2]	7.37	11	340-400
E P	7.04	16	150-220
E P	7.12	19	240-280
E P (V)	7.03	23	
E P (V)	6.58	27	10-35
E P (K)	7.37	8	280-380

b) rock wool

Material	Optical microscopy		CNC
	Total sample flow (m^3)	Fibers (x $10^{-6}/cm^3$)	particle concentration (x $10^{-3}/cm^3$)
B P[3]	7.08	4	20-50
B P[3]	7.08	7	20-50
B P (K)	6.82	30	
B P (K,V)	7.62	10	60-110
C[3]	7.01	8	60-90
C[3]	7.10	10	50-80
F P	7.45	2	30-70
F P (V)	7.22	14	100-160
G P	7.41	2	
G P	7.37	12	30-60
F P (K)	6.75	8	15-40
F P (K,V)	7.13	5	15-40
H	6.50	18	35-70
H	6.61	13	35-80
H (V)	6.57	24	20-40
H (K,V)	7.24	6	30-55
H (K)	6.88	15	20-50
H (K)	7.37	5	

1) old glass wool material
2) sawed surface
3) old rock wool material

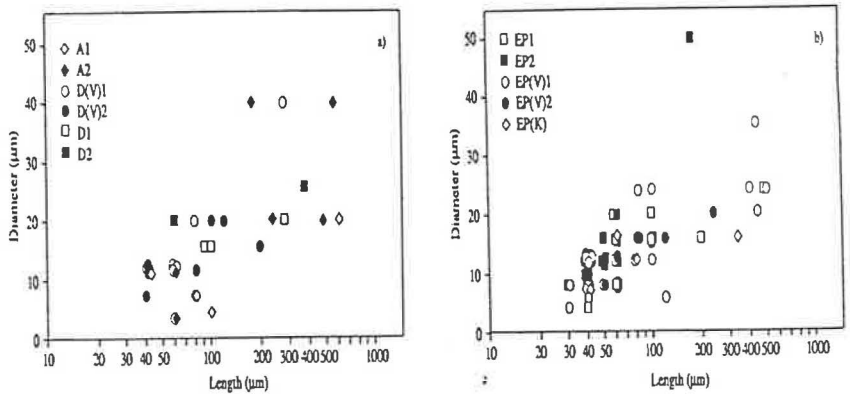

Fig. 3. The size of fibers emitted from glass wool materials a) without and b) with a specific surface covering.

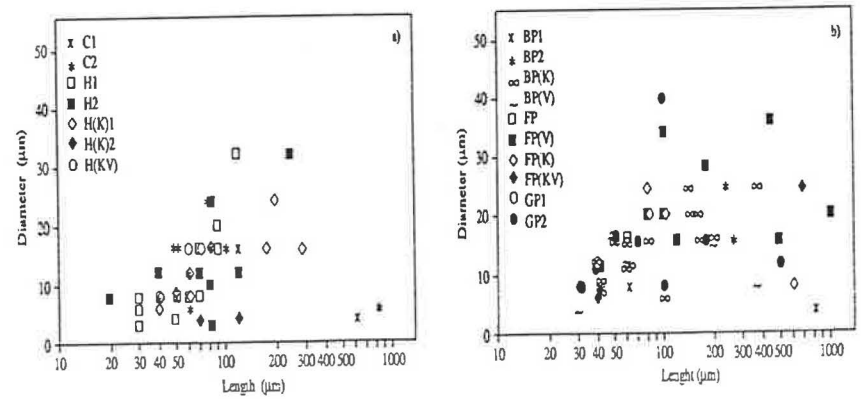

Fig. 4. The size of fibers emitted from rock wool materials a) without and b) with a specific surface covering.

DISCUSSION

Glass wool material covered with the specific surface emitted some more fibers and small particles than the material without the covering. On the other hand, the rock wool material covered with the specific surface emitted fewer fibers and small particles than the material without the covering. When the materials were covered with a steel screen, they usually emitted more fibers. However, in the case of glass wool, fewer small particles were emitted. The materials that were first wetted and then dried did not emit an exceptional number of fibers, but they did allow the emission of differently sized fibers.

The method developed in this work appears to be applicable for the determination of fiber emissions from sound absorbent materials. In the case of sound absorbent materials, only when the concentration of background particles in the testing chamber is low enough, the small particle emissions from materials can be measured microscopically from the filter samples. The fiber levels of the sound absorbent materials tested were very low in comparison with hygiene limits.

ACKNOWLEDGEMENTS

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REFERENCES

1. Brown RC & Hoskins JA. Contamination of Indoor Air with Mineral Fibres. Indoor Environ. 1992; 1:61-68.
2. Schumate MW & Wilhelm JE. Air Filtration Media - Evaluations of Fiber-Shedding Characteristics Under Laboratory Conditions and in Commercial Installations. In: IAQ '91 Healthy Buildings, September 4-8, 1991, Washington DC, USA. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, 1991; 337 - 341.
3. Cherrie J. & Shelfox R. Airborne Dust Levels Generated during Insulation with MMMF: A Laboratory Investigation. Edinburgh, Institute of Occupational Medicine. Technical Memoranda, 1990; 38 p.
4. Gamboa RR,, Gallagher BP. & Matthews KR. Data on Glass Fiber Contribution to the Supply Airstream from Fiberglass Duct Liner and Fiberglass Duct Board. In: Engineering Solutions to Indoor Air Problems. Proceedings of the ASHRAE Conference, IAQ '88, April 11 - 13, 1988, Atlanta, Georgia. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, 1988; 25 - 33.
5. Federal Standard No. 209B. Clean Room and Work Station Requirements, Controlled Environment. General Services Administration. 1973; 35 p.

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