

SIZE CHARACTERIZATION OF INDUSTRIAL PRODUCTS (MMMF) USED IN BUILDINGS AND STRUCTURES AS SUBSTITUTES OF SPRAYED ASBESTOS-CONTAINING MATERIAL

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INTRODUCTION

It is known the fire risk prevention problem has determined a very wide use of insulation materials and mainly of asbestos, as a consequence of its desirable physical and chemical properties. For these purposes it has been used in many different industrial sectors, and particularly in considerable quantity in the building industry. In this last field insulation products are mainly used as surfacing materials and partitions to provide both protection from fire spread and acoustic insulation.

In the past, asbestos was sprayed extensively on structural steel structures and decks as fireproofing to enhance their fire resistance. Such use was required in Italy by national regulations on fire prevention.

The health hazard due to the inhalation of airborne fibres arises from dust release in air caused by an aging process, bad maintenance or vandalism actions. All those facts have induced many governments to regulate the use of asbestos products and to ban asbestos-sprayed techniques.

Like in some other countries the Italian Health Ministry has taken urgent measures for asbestos-control in schools and hospitals (circ.n.45 on 10.7.86). Such measures aim at identifying the presence of asbestos and to check if it is in good condition or if there is a potential release of asbestos dust into the air. In this case there will be a health risk and asbestos should be removed. These measures have determined indirectly a lot of work in order to remove asbestos materials from buildings, even if they were not in bad conditions.

Fibrous alternative materials (with the same heat and fire resistance) are generally used as substitutes for asbestos. At present, alternative products are available on the market with a silicate like chemical composition and various morphologies, either fibrous or not-fibrous. Most of them have amorphous structures. As a rule, fibres of alternative products have a diameter coarser than asbestos-fibres, although some of them have size similar to asbestos. Generally such man-made mineral fibres (MMMF) are manufactured with different diameters relating to the specific use they are destined. The most important MMMF are grouped in: slag wools, rock wools, glass wools and continuous filament with diameters varying from 1 up to 20 μm , averaging about 8 μm for filament glass fibres 1-5 μm for insulation wools.

Often a considerable percentage of these fibres shows diameters in the range from less than 3 μm to 0.2 μm .

In this paper, special attention is given to representative products used in public buildings as banks or offices, as substitutes for asbestos.

These materials have been sent by U.S.L. (Local Sanitary Unit) to our Institute to obtain all information about their chemical composition and size characterization, in order to decide their use as asbestos substitutes.

In a recent summary report of WHO-IARC international symposium,¹ an increased lung cancer risk has been reported among workers exposed to small-diameter fibres since the early days of man-made mineral fibres production. The risk has been greater in the rock or slag wool sector than in the glass wool one. Moreover the IARC has revised of carcinogenicity and it has classified MMMF as possibly carcinogenic to humans (Group 2B).

The cancerogenic activity is generally attributed to the fibre dimensions and to their durability in biological tissues. Today the opinion of the scientific community based on the epidemiological, toxicological and mineralogical studies, indicates that any mineral fibre with specific dimensions and sufficient biological durability must be regarded as possibly cancerogenic.

MATERIALS AND METHODS

All materials studied appear composed of fibrous elements and a low density matrix of rounded aggregates. The color is usually brown to white. Inspection of the bulk materials by a stereomicroscope at about 40 X show a very friable consistency and a largely empty structure. Fibres show a wide range of diameters and often they are in association with unfiberized particles mostly in the form of solidified droplets.

Few milligrams of the bulk materials, taken at random were shaken into a beaker with a "policeman" for a few minutes using H₂O₂ in order to help particle disgregation and dispersion.

Because of the mechanical treatment, fibre length distribution was not determined in the subsequent analysis. Material was then dispersed in prefiltered distilled water. Aliquots of the suspension were filtered through a polycarbonate filter (NPF), 25 mm diameter, 0.2 μm , by a small funnel (Nuclepore Corp.).

A quarter of each filter was mounted on a carbon stub, 12 mm diameter and coated by a gold layer of approximately 100 nm of thickness.

The samples were analyzed by scanning electron microscope, Cambridge model 200, at 0° tilt angle, 25 KV accelerating voltage. Fibre size was measured directly on the screen, separately recording diameters of 100 fibres.

The airborne samples were collected on 25 mm 0.8 microns cellulosic filters. Half of the filters were cleared and examined by phase contrast optical microscope (PCOM) method. The remaining portion of the filters were mounted on a carbon stub in the same way, but examined by SEM at 15 KV acceleration voltage in order to prevent local overheat.

RESULTS

Table I shows size distributions from bulk samples of materials used as sprayed insulations in buildings.

From diameters distributions it results that in samples 2 and 5 the respirable fraction (diameters less than 3µm) is about 30%, while in the other samples the same fraction is about 60%.

During the removal operation from building structures coated with the material of sample n.1, personal air samples were collected according to the standard method.²

Table II shows a consistent size distribution by diameter and by length of airborne respirable fibres from 4 different samples.

Table I
Frequency of Diameter in the Bulk Materials

Sample	D = 1	1 D 3	3 D = 5	D 5
1	29	39	22	10
2	6	27	33	34
3	20	41	26	13
4	25	35	25	15
5	10	19	34	47

Table II
Size Distribution of Airborne Respirable Fraction

A) Distribution by diameter

μm	D = 1	1 D 2	2 D 3	D 5
%	39	44	15	2

B) Distribution by length

μm	5 L 10	10 L 15	15 L 20	20 L 30	30 L 100	L 100
%	41	18	13	15	11	5

In this case the respirable fraction is about 98% showing a clear preferential loss of coarser fibres. About 40% of these fibres are between 5 and 10 microns in length, and the rest is equally distributed among the subsequent length classes.

Chemically fibres consist principally of silicon, calcium and aluminium. Other elements such as iron, magnesium, potassium are also present.

CONCLUSIONS

Recently there has been an increasing demand for insulation products and especially of man-made mineral fibrous materials to replace asbestos-products.

Owing to the possible fibre release from MMMF insulation

materials in bad conditions, sometimes they have been removed from structures.

The results from this study, even if limited, indicate that the physical characteristics of MMM products show 50% diameters less than 3 microns, while during the removal about 98% of airborne fibres have diameters less than 3 microns.

Although, at present, investigation³ carried out in different countries unnecessary exposures to these types of fibres.

Finally, it seems important that clear information be reported on appropriate labels in which should appear not only technical instructions, but also chemical data as well as the diameter range of fibres in order to evaluate the possible risk of people exposed.

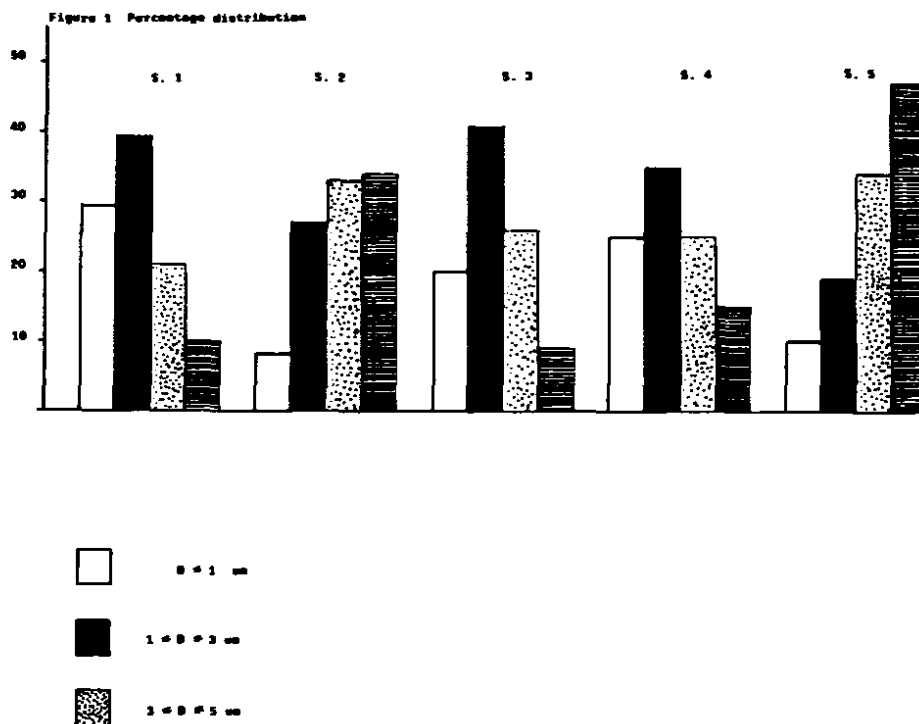


Figure 1. Distribution of fibre diameters of bulk materials.

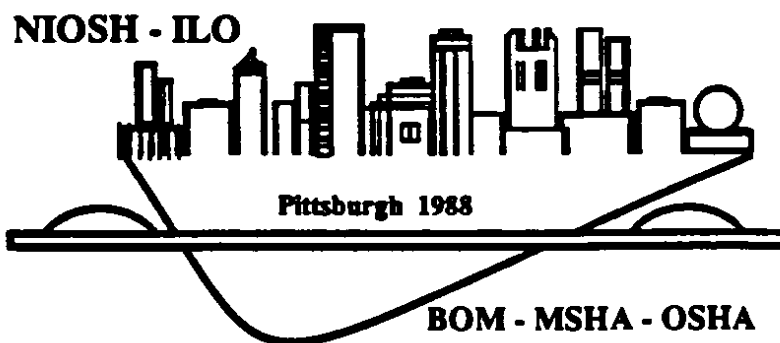
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