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Occupational Asbestos Exposure and Methods of Monitoring

The determination of asbestos in the air and working environment is crucial for ensuring the safety and health of individuals who may be exposed to this hazardous material. Asbestos is a group of naturally occurring minerals that have been widely used in construction, manufacturing, and other industries due to their heat resistance and durability. However, asbestos fibres are known to be carcinogenic and can lead to serious health issues when inhaled. Research conducted so far indicates that individuals exposed to asbestos in their workplace face the highest risk of developing diseases associated with asbestos exposure.

Asbestos is a general term for a group of six fibrous mineral silicates that can be divided into two groups, amphibole (amosite, actinolite, anthophyllite, crocodolite, tremolite) and serpentine (chrysotile). They are naturally occurring minerals that usually form long filaments that tend to split along their length. Numerous industries put workers at high risk for asbestos exposure. High-risk occupations include workers who manufactured, installed, or removed asbestos products, e.g. aircraft and auto mechanics, construction and industrial workers, firefighters, machinists, and many others. Despite global regulations that either prohibit or control the use of this material, the uncertainty regarding the levels of asbestos fibres in the environment resulting from various sources of exposure persists.

Asbestos in the workplace has to be controled, especially in the construction industry

Determining the presence of asbestos is critically important before demolishing old buildings due to the serious health risks associated with asbestos exposure. Asbestos was widely used in construction materials for its heat resistance and durability. However, when these materials degrade or are disturbed during demolition, renovation, or maintenance activities, they can release asbestos fibres into the air. Inhalation of these airborne fibres can lead to various health problems, including severe respiratory diseases and cancer. Asbestos in buildings is most often found in ceiling sealants, roofing materials, plaster walls, gaskets, and certain cement flooring.

Asbestos Monitoring in Air Samples.

The concentration of asbestos in air samples can be monitored by two methods: stationary sampling, which measures the quantity of airborne fibres in a monitored area, and personal sampling, which monitors the exposure of workers while handling asbestos materials. In both methods, a specified volume of air is filtered, and the collected sample is later analysed in the laboratory using a microscope.

Figure 1. Stationary Sampling of Working Environment

Figure 2. Personal Sampling of Working Environment

Methods for Asbestos Determination

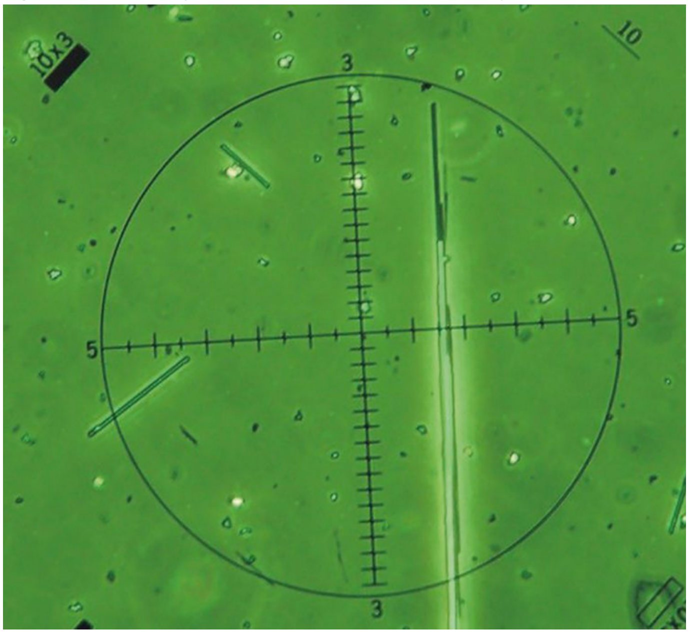
There are two basic methods widely used for the analysis of asbestos in the working environment: the Phase Contrast Microscope (PCM), and electron microscopy (SEM – Scanning Electron Microscopy, TEM – Transmission Electron Microscopy). Only respirable fibres are always counted, as they have the greatest potential to penetrate deeper into the lungs. Respirable fibres are fibres longer than 5 μm, narrower than 3 μm and with a length to width ratio greater than 3:1.

Phase Contrast Microscopy (PCM) Method

PCM is one of the initial techniques used to assess the concentration of asbestos fibres in the air. This method is primarily used for monitoring the exposure levels of workers when working with asbestos materials. Like any method, it has its advantages and disadvantages. On the positive side, it offers quick results and is cost-effective. However, a notable limitation is PCM inability to differentiate asbestos fibres from other mineral fibres. Therefore, it is best suited for analyses where it is known that workers were handling asbestos materials.

The process involves passing the air through a cellulose filter, followed by a laboratory analysis using the Phase Contrast Microscopy (PCM). This method enhances the visibility of transparent and low-contrast objects, such as asbestos fibres. The microscope is equipped with phase contrast objectives and condensers. To ensure accurate measurements, a glass slide with a known size reference (Walton-Beckett ring in our case), is placed in the microscope's field of view. This reference is used to calibrate the microscope and establish a size scale for particles. Subsequently, respirable fibres with at least one end within the ring are counted across 100 fields. Using the known air volume and the analysed filter area, the concentration of asbestos and mineral fibres per cubic centimetre (cm^3) can be calculated. The limit of the method is 0.01 fibres/cm^3.

Figure 3. PCM Analysis of Asbestos Fibres in Air Samples.



Scanning Electron Microscopy (SEM) Method

The primary application of SEM method is the analysis of filters obtained from stationary air sampling.
The analysis is based on the recognized standard VDI 3492.
The main advantage of SEM method is the ability to distinguish between asbestos and mineral fibres, offering clients a more accurate assessment of asbestos levels in the air. Respirable fibres are sought on a polycarbonate filter, which are then subjected to elemental analysis and identified as asbestos, mineral fibres, or other types of fibres. This method is employed for overseeing areas that have been in contact with asbestos materials. Before such spaces are released for regular use, it is necessary to declare that they meet strict national limits for asbestos concentration in the air. During the sampling process, fibres are captured on a polycarbonate filter, which is subsequently analyzed in the laboratory using an electron microscope. At a magnification of 2000x, a known area of the filter is examined, and then this is recalculated to represent the sampled volume of air. The analysis is slightly more demanding than the conventional optical method but offers a significantly lower limit of 0.0001 fibres/cm^3.

Figure 4. SEM Analysis of Asbestos Fibres in Air Samples.

The Current State of European Legislation

The Council has reached a preliminary agreement with the European Parliament on a new legislation aimed at enhancing the protection of workers against asbestos exposure risks.
After a maximum transition period of 6 years, member states will need to adopt an electron microscopy as a golden standard method for asbestos measurement and member states will have two choices:
1) to measure thin asbestos fibres, in which case the maximum exposure limit will remain at 0.01 f/cm^3.
2) not to measure thin asbestos fibres, but the maximum exposure limit will be lowered to 0.002 f/cm^3.

