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COMPARISON OF SEVERAL ASBESTOS-DUST MEASURING METHODS FOR THE DETERMINATION OF MASS AND PARTICLE CONCENTRATIONS

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1. Introduction

For the determination of the concentration of mineral dust liable to cause pneumoconiosis, many methods have been developed in the different countries. As to the measurement principle involved, the corresponding instruments can be divided into two groups:

1. Instruments for the determination of the particle number;
2. Instruments for the determination of the mass concentration.

This classification is valid for both quartz- and asbestos-containing dust. At the beginning of the twenties, the so-called Impinger device for dust measurement was developed in the U. S. A., which, in the years 1937 - 1938, was elaborated into the Midget Impinger Method /1/. As is known, this method is based on the collection of the dust particles in a suitable absorption liquid and on the microscopic counting of these particles in the sedimentation chamber. In Finland, occupational hygiene has started to develop according to the American pattern only in the fifties. We thus applied the Midget Impinger Method for dust measurements, especially as this method was already associated with recommended MAK values.

Due to lacking understanding of the noxiousness of asbestos dust, only a few dust measurements were carried out in the Finnish asbestos industry during the fifties. Spurred on by the many diagnosed asbestosis cases, extensive dust measurements were initiated only in the sixties. As, however, the Midget Impinger suffers from a number of disadvantages (short sampling time, difficult particle counting, broad scattering of the results, nonseparation of the smallest particles, etc.), we have begun, five years ago, to perform simultaneously with the Impinger measurements also gravimetric measurements, using an electrostatic precipitator and membrane filters, to determine the mass concentration of the dust. The idea was to develop a simple method for the monitoring of dust concentrations in the asbestos industry, which could be applied on the spot. In the course of time, the electrostatic precipitator method was dropped, as both methods yielded completely comparable results, while it was much simpler to use the membrane filter. During the last 1 1/2 years we have carried out particle counting on the membrane filter under the phase contrast microscope, in addition to the conventional particle concentration determination with the Midget Impinger Method. In the following we intend to report on our experience, during the last five years, with measurements of asbestos dust in an anthophyllite asbestos factory and in several asbestos cement plants using also other asbestos types (chrysotile, amosite, crocidolite and some anthophyllite), as well as in a asbestos textile factory.

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2. Measuring methods

2.1. Particle counting methods

With the Impinger method, dust-laden air is led through an Impinger-gas washing bottle containing 10 cm³ ethyl alcohol. Air is drawn in by a battery-powered pump (MSA Personal Sampler) at a rate of about 2.5 l/min. The sampling period is 5 or 10 min. Evaluation of the dust sample is performed under the microscope in the bright field at a magnification of 300x. Upon counting of the asbestos dust, for which we used an eyepiece graticule (Whipple), the particles were classified as follows:

- a) particles smaller than 5μ,
- b) particles larger than 5μ,
- c) needles longer than 5μ,
- d) needles longer than 10μ.

Needles are defined as particles the length of which is at least 3 to 4 times their width.

With the membrane filter method for determination of the particle number, the air, drawn in by a pump (MSA Personal Sampler), is led through a membrane filter (Millipore filter, type AAWP 037 in the Aerosol Field Monitor). Air throughput is about 0.5 to 1.0 l/min, sampling time 5 to 10 min. The samples are prepared according to the methods of the U. S. Public Health Service /2/, a piece of the filter on the specimen carrier being made transparent with the aid of a mixture of dimethyl phthalate and diethyl oxalate. The particle concentration and particle size distribution is for the time being determined in the main according to the above-mentioned method of the U. S. Public Health Service. The dust particles are divided into the following four groups:

- a) particles (grains), total concentration (P/cm³),
- b) needles, total concentration (needles/cm³),
- c) needles, length exceeding 5μ (needles > 5μ/cm³),
- d) needles, length exceeding 10μ (needles > 10μ/cm³).

Counting is effected with the aid of the phase contrast method (microscope Leitz, type Ortholux, with objective Phaco NPL 40/0.65 and eyepiece Periplan GF 10x M). Counting is carried out at a total magnification of 500x. The graticule used with the eyepiece is either of the Porton or of the Patterson type.

2.2. Determination of the mass concentration

We use membrane filters (Millipore filter, type AAWP037 in the Aerosol Field Monitor) together with a pump and a gas