MEP 01

III međunarodni simpozijum

RUDARSTVO I ZAŠTITA ŽIVOTNE SREDINE

ZBORNIK RADOVA
PROCEEDINGS

MI... ENVI...ENTAL PROTECTION

Third International Symposium

Beograd - Vrdnik, 21–23.5.2001.

FIBROUS SILICATES IN THE ENVIROMENT

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ABSTRACT: An assay of the presence of serpentine minerals in some samples from dust and isolation materials taken at a cement-asbestos factory is presented in this paper. Also is presented a different methodology which was used for this purpose.

Keywords: serpentine mineral, asbestos, dust, isolation materials

INTRODUCTION

Serpentine minerals, with incompletely elucidated structural polytypes as well as not thoroughly defined thermodynamic conditions of formation, are even nowadays found attractive for research. Putting asbestos in the group of minerals harmful for the human health greatly intensified the interest for research of this group, as well.

The serpentine minerals are divided into chrysotiles, lisardites and antigorites, and recently, another group of so called polygonal serpentinites is established (Kunze, 1958; Zussman et al, 1975; Uehara & Shirozu, 1985). The chrysotile (Midgley, 1951; Melini, 1982) group is considered most important because chrysotile, usually called white asbestos, is the most abundant serpentine mineral, which constitutes more than 98 % of world production. Besides the serpentine group, asbestos includes: the amphiboles containing amosite (brown or gray asbestos), crocidolite (gray asbestos), tremolite, actinolite and anthophyllite. On the other hand, a lot of minerals with fiber forms are not considered as asbestos because of their other characteristics.

Asbestos is a naturally occurring substance with certain very useful properties. Asbestos-reinforced cements absorb nearly two-thirds of the world's annual production of chrysotile, it is used in corrugated and flat roofing sheets, pressure pipes and ducts, and many other hard-wearing, weather-proof, long-lasting products. Long-fibered chrysotile (fiber length >20 mm) is moved into asbestos textiles for fire-fighting garments and numerous fireproofing and insulating applications.

The serpentine asbestos can easily be mechanically separated as 0.8 □m thick fibers, whereas the amphibole asbestos is more likely to be bent in spirals and blocks. The serpentine asbestos fibers are usually 10 mm long (very rarely longer than 50 mm), very soft and inelastic, sensitive to acids and resistant to alkali. The amphibole asbestos fibers, on the other hand, are usually 50 mm long (rarely longer), more or less solid and rigid (except crocidolite), resistant to acids and seawater.

Putting asbestos in the group of minerals harmful for the human health greatly intensified the interest for research of its medical aspects. Prolonged exposure to airborne suspensions of all types of asbestos fiber dust can be very dangerous and is connected with the incidence of asbestosis (non-malignant scarring of lung tissue), lung carcinoma and mesothelioma. Unfortunately, there is an extended latent period (typically 20-30 years) before these diseases are manifest. In spite of many data about these diseases, the mechanism of their development caused by asbestos is still not elucidated. Stringent precautions are now enforced in many countries and the incidence of the diseases appears to be falling steadily.

It has also been shown that the risk of asbestos greatly depends on the asbestos type. Amphibole asbestos is more hazardous than the chrysotile type owing to their mechanical and chemical characteristics. The chrysotile type is softer. it penetrates more difficult into tissues and is decomposed in a few months, whereas the amphibole type fibers are very rigid, more easily penetrate into tissues and are not destroyed in the lungs, which prolongs their elimination to about 5 years. So, when speaking of environmental analysis, these two types of asbestos should be clearly distinguished.

Five types of asbestos are already banned by an EU ban introduced in 1991. The only exception was chrysotile, which was banned in some products, but permitted for use in others. The new Directive will extend the existing ban to cover almost all the remaining uses of chrysotile, with a few minor exceptions (e.g. for diaphragms used in chlorine plants for electrolysis).

The aim of this work is examination of the serpentine minerals-asbestos in samples of some floor dust (taken near a cement-asbestos factory) and isolation materials, as well as to present different methodology which can be used for this purpose.

EXPERIMENTAL

The collected samples were studied microscopically by optical polarized microscope type Amplival, Carl Zeiss Jena and stereomicroscope Carl Zeiss Jena with magnifying power of 10 to 100.

The samples were analyzed by X-ray diffraction using the instrument SIEMENS D 500 (computer supported) with Cu monochrome light at 40 KV/30 mA. The optimal signal to noise ratio was automatically obtained using the computer PDP 11/23+. Diagnostics of the phases present in the samples was performed using the software package DIFRAC 11 with the programs EVAL and IDR. The samples were prepared for analysis with minimal orientation for recording an adequate diffraction portion 2θ = 3-70°.

The thermal examinations were performed using a Derivatograph Q-1500-D with the following settings: sample size 500 mg; sensitivity of TG 200 mg; sensitivity of DTA 250 □V and DTG 500 □V; heating rate 10 °C/min; temperature range from 15-20 °C to 1000 °C; inert medium Al_2O_3; atmosphere in the oven – air without turbulence.

The infrared spectra were recorded using the infrared interferometer Perkin Elmer System 2000 FT-IR (resolution 4 cm^{-1}, OPD rate 1 cm/s, 32 background and 64 sample scans) from KBr pellets. The software package GRAMS 2000 was used for acquisition of spectra, and GRAMS/32 was used for analysis of spectra.

RESULTS AND DISCUSSION

The methodology for treatment of the samples includes sample preparation by grinding, sowing and concentration, and then optical methods for treatment. The pretreated samples were then analyzed using X-ray powder diffraction method, infrared spectroscopy and differential thermal methods.

The material for analysis was at first prepared for optical investigation using optical binocular and polarized light. These methods can indicate the presence of minerals of the serpentine group.

In the sample from the floor dust significant quantity of asbestos was detected using stereomicroscopy, whereas polarized microscopy indicated that it is a chrysotile type of asbestos. The estimated asbestos content is about 10 %.

The same sample was then analyzed by X-ray diffraction (Fig. 1). The mineral calcite, quartz and gypsum were found as main components in this sample. The content of chrysotile determined was 12.3 %. Larnite and an organic component with maximal temperatures of combustion of 350 and 460 °C were detected as well.

The infrared spectrum of the sample (Fig. 2) was also recorded and the presence of asbestos of chrysotile type was evident with the content corresponding to the one obtained by X-ray diffraction. The infrared spectrum indicates the presence of significant amounts of carbonates, gypsum, silicate and some organic compounds, as well.

In the sample taken from dust of isolation material, the X-ray diffraction analysis showed that it is mixture composed of minerals of the serpentine-caolinite group, quartz and carbonate minerals of the calcite group.

Having in mind the suggestion not to use serpentine minerals in isolation materials, additional examination of this sample was performed in order to get more precise characterization of the constituents. The mineral aggregate was exposed to ethylene glycol vapor for 48 hours and after that, the powder X-ray diffractogram in the region of the most intensive reflexes of this group was recorded once again. No remarkable change of the position of the reflexes, especially of the (001) reflex was found. Only a slight insignificant decrease in the intensity of this reflex was observed, which can be caused by the sample preparation. These oscillations of the intensity are not unusual for the filosilicates. This result excludes the possibility of these minerals to be from the smectite group (clay minerals which swell up soaking)

The mineral aggregate was then heated up to 400 °C during half an hour, which helps