Phase contrast method for asbestos fibres determination

Uporaba metode faznega kontrasta za določanje azbestnih vlaken

Meta Dobnikar[1, *]

[1]Ministrstvo za izobraževanje, znanost, kulturo in šport, Direktorat za visoko šolstvo in znanost, sektor za visoko šolstvo, Kotnikova 38, SI-1000 Ljubljana, Slovenia

*Corresponding author. E-mail: meta.dobnikar@gov.si

Received: September 24, 2012 **Accepted:** September 27, 2012

Abstract: Certain diseases, such as lung cancer or pleural mesothelioma are highly connected to inhalation of asbestos fibres. Asbestos is therefore considered as hazardous material. Use of chrisotile is forbidden in technologically advanced countries, and defined as asbestos is all material, having more then 1 % asbestos fibres. Using optical microscopy and phase contrast method, asbestos fibres were qualitatively and quantitatively determined in different soil and dust samples. The method was proved to be accurate and convenient. Most of the examined material was determined as asbestos.

Izvleček: Pojavi določenih bolezni, kot je na primer pljučni rak ali plevlarni mezoteliom, imajo močno povezavo z izpostavljenostjo oziroma vdihavanjem azbestnih vlaken. Azbest je zato obravnavan kot zdravju nevaren material in uporaba hrizotila je v industrijsko razvitih državah prepovedana. Kot azbest se obravnava vsak material, ki vsebuje več kot 1 % azbestnih vlaken. Z uporabo optičnega mikroskopa in metode faznega kontrasta je bila kvalitativno in kvantitativno določena vsebnost azbestnih vlaken v vzorcih tal in prahu. Metoda se je izkazala za primerno oz. bolj natančno za namen določanja vsebnosti azbestnih vlaken. Ugotovili smo, da večina preiskanih materialov vsebuje več kot 1 % azbestnih vlaken in jih lahko opredelimo kot azbestne materiale.

Key words: asbestos, phase contrast method, optical microscopy
Ključne besede: azbest, metoda faznega kontrasta, optična mikroskopija

Professional paper

INTRODUCTION

The term "asbestos" is used for fibre occurrence of different minerals, silicates from amphibole and serpentine group. Asbestos fibres are defined as crystals with length to diameter ratio at least 3 : 1, if length is more then 5 μm and diameter less then 3 μm (FALINI et al., 2003). Amphibole and serpentine group minerals are highly resistant, chemically inert and stable, forming flexible and solid fibres. Asbestos was, due to its chemical and physical properties, commonly used in industry, especially in civil engineering and fire resistant materials. Near to 95 % of asbestos used belongs to mineral chrisotile, with ideal chemical composition $Mg_3Si_2O_5(OH)_4$, fibrous variety of serpentine, trioctahedral magnesia analogue of kaolinite, 1 : 1 alumosilicate. As certain diseases, such as lung cancer or pleural mesothelioma are highly connected to inhalation of asbestos fibres, it is considered as hazardous material (FALINI et al., 2003). Asbestos fibres are too small to be expelled from inhalation path by human natural defence system, therefore they enter into the body by inhalation paths and deposit in human lungs. Use of chrisotile is forbidden in technologically advanced countries, EPA (Environmental Protection Agency) defined as asbestos all material, having more then 1 % asbestos fibres (BURDETT, 2006).

Recommended method for asbestos fibres determination is optical microscopy in plane polarised light. The method is relatively inaccurate when asbestos content is around 1 %. Analysis results turn out much better in combination of this optical microscopy method with phase contrast method, when content of asbestos fibres down to 0,1 % may be determined. It is worth noting that fibres with diameter less then 1 μm difficult to determine by optical microscope (BURDETT, 2006).

THE PHASE CONTRAST METHOD

The resolution of optical microscope depends on its quality and is around 5 μm. For qualitative and quantitative determination of asbestos fibres the two methods (optical microscopy in plane polarised light and phase contrast method) have to be combined. Material is observed in immersion with appropriate refraction index and dispersion. Nitrobenzol is used most commonly.

At phase contrast method optical microscope with polarised light is used. There is phase plate inserted within objectives, to change phase light changes into amplitude light changes in order to enable phase objects (objects as small grains or fibres, that only change the phase of the light) to be seen under the microscope. Con-

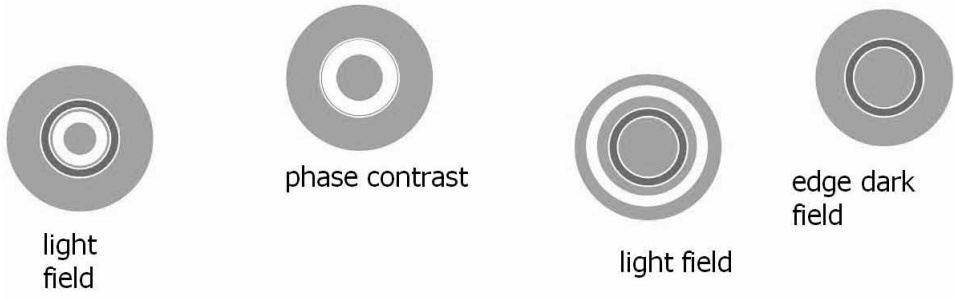

Figure 1. Phase plate (dark circle) and light circle projection at the objective.

denser annulus is used to gather the light into a ring. The size of the light ring can be changed, so we may successively observe bright field (light ring smaller then phase plate ring), phase contrast field (light ring just the same size as phase plate ring), bright field (light ring larger then phase plate ring) and edge dark field (light ring at the edge of visible field) (Figure 1). Asbestos fibres are colourless and therefore hardly visible in polarised light, are typically coloured in phase contrast, so qualitative and quantitative analysis of the fibres is enabled.

Example of asbestos fibres analysis in soil samples and air filters

33 samples of soils and air filters were analysed qualitatively and quantitatively for asbestos fibres content, using the phase contrast method. 26 samples of soil and 7 air filters were analysed.

Samples of soils and filters were examined in phase contrast using Leitz Wetzlar optical microscope (Figure 2), with condenser annulus and objectives with phase plates used.

Samples were analysed at objective 40-times and ocular 10-times. Immersion of nitrobenzole ($C_6H_5NO_2$), with refraction index 1.55 was used. When counting asbestos fibres, those of width less then 3 μm, and length more then 5 μm and less then 15 μm, with width to length ratio ≤1 : 3 were considered.

In air filter samples, all asbestos fibres within 1 cm^2 area of the filter were counted.

In soil samples, mineral grains were counted according to the method of regular profiles. All grains within linear horizontal profile were counted. Vertical distance between the profiles and one step on the profile were 0.4 mm. 500 mineral grains of each sample were counted. Results are presented in the number of respirable asbestos fibres per 100 mineral grains (Table 1).

Table 1. Results of the asbestos fibers counting with optical microscope phase contrast method:

sample	No. of respirable asbestos fibers per 100 mineral grains
S-1	0.5
S-3	3
S-4	4.7
S-5	1.5
S-7	1
S-11	6.2
S-12	5
S-16	2.4
S-20	4.4
MK-4	1
MK-9	11.8
MK-11	0.8
MK-19	0
Uz. iza igr.	6.4
Uz. tlo (igr.)	5
BS1-2	1.6
BS1-5	6.4
BS1-6	5.2
BS1-7	5.6
BS1-8	1.2
BS3-1	1.6
BS3-2	7.4
BS3-3	6.8
BS8-3	17.2
BS9-4	1.6
BS9-5	7.4
Filters	**No. of respirable asbestos fibres per 1 cm^2**
U1	256
U2	177
U3	193
US1	349
UV10	106
UX2	134
UP3	2331

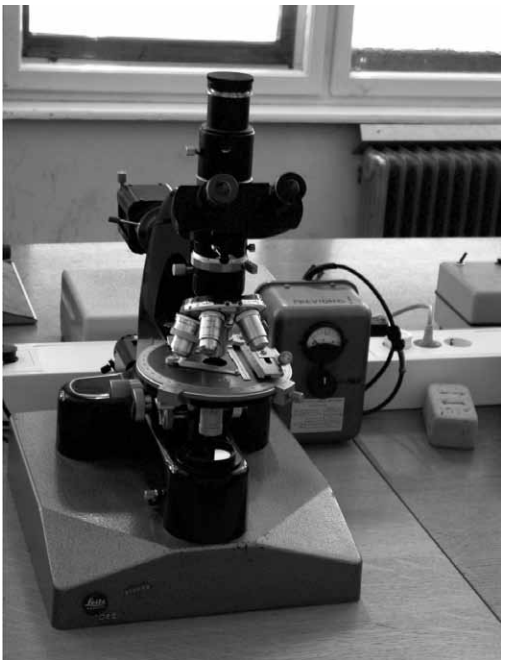

Figure 2. Optical microscope Leitz Wetzlar

Conclusion

Respirable asbestos fibers were quantitatively determined in soil samples as well as in air filters with the use of phase contrast method. The selected method proved to be adequate and accurate. Results of analysis show that the majority of analysed samples contain more then 1 % of asbestos fibres, and should be considered as hasardeous, asbestos containing materials.

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