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FTIR ASBESTOS PRESENCE IDENTIFICATION IN THE OCCUPATIONAL ENVIRONMENT

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abstract: In this work, an IR technique has been developed to identify the presence of the different types of asbestos in the occupational environment. A Fourier transform IR spectrometer type Jasco 460 Plus was used. The procedure has the advantages that it allows relative simple and rapid qualitative evaluations of various types of asbestos and can be useful as screening method for the detection of asbestos in occupational environment.

key words: asbestos, identification, occupational environment, FTIR method

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1. Introduction

Asbestos is a term used to describe hydrated fibrous silicates of magnesium, iron, sodium, calcium and aluminum, classified in two mineralogical groups: *serpentine* group (that includes chrysotile) and *amphiboles* group (that includes crocidolite, amosite, actinolite, anthophyllite and tremolite).

Pathological effects associated with occupational exposure to asbestos include a series of chronic diseases (asbestosis and cancer) that have a high mortality [1,2]. Therefore, the occupational exposure monitoring represents the absolute measure in order to assure the workers' health.

Since January 2007, in Romania, asbestos commercializing and use were forbidden, excepting a series of economic activities (maintenance, reparations and waste treatment). Therefore, the occupational exposure was diminished, but it was not eliminated. The diseases related to asbestos appear after 20-40 years since first exposure and in these conditions, an exposure rigorously control is necessary, especially asbestos presence identification in the working environment.

In the past, in Romania, asbestos in the occupational environment was determined only quantitatively. At present, asbestos qualitative analysis in the working environment is first step in the occupational exposure evaluating.

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In this work, in order to identify the presence of different types of asbestos in the occupational environment a FTIR method was developed. Example of this FTIR procedure applied to the manufacturing of asbestos gaskets technological process is presented.

2. Experimental

Air samples with a flow rate of 1 L/min. in working environment were collected using membrane filters (containing mixed esters of cellulose) with the pore size of 0.8 µm and 25 mm diameter. The filter diameter must be appropriate to the sampler used. The filters were inserted into open-faced filter holder fitted with an electrically-conducting cylindrical cowl extending between 33 mm and 44 mm in front of the filter [3]. The filters holders were attached of personal pumps type HFS 113A (New Jersey Instrument Corp., USA) and then the pumps were attached of worker's body, they being powered by batteries. A minimum amount of 2 mg of dust must be collected on filter.

After ashing the membrane filter, using a muffle furnace, 1 mg sample ash was pressed into a KBr pellet using standard technique and analysed by Fourier transform infrared (FTIR) spectroscopy [4÷6].

A Fourier transform infrared spectrometer type Jasco 460 Plus was used.

FTIR spectra range from 4000 to 400 cm^{-1} were recorded for these samples and compared with the standard spectra [7,8]. As standards, asbestos samples obtained from l'Union Internationale Contre le Cancer, Lyon, France (U.I.C.C. standard asbestos samples) were used.

Two industrial technological processes were investigated: manufacturing of asbestos gaskets and manufacturing of asbestos cement and asbestos cement products.

3. Results and discussion

Fig. 1 illustrates FTIR spectra of five varieties of U.I.C.C. asbestos, recorded in the transmittance mode, the resolution being 4 cm^{-1}.

The absorption maxima of U.I.C.C. standard asbestos samples are listed in Table 1; the assignments for the peaks are consistent with those existent in literature [9÷12].

Table 1 Infrared absorption bands of U.I.C.C. standard asbestos samples.

No	Assignment	Vibrational frequency (cm^{-1})*				
		Chrysotile a	Chrysotile b	Crocidolite	Amosite	Anthophyllite
1	OH-stretching vibration	3689 vs 3644 m	3691 vs 3646 m	3648 m 3635 m 3618 m	3652 m 3637 m 3618 m	3680 w 3675 s
2	Si-O stretching vibration	1069 s 1033 s 959 s	1078 s 1023 s 955 s	1142 s 1104 s 989 vs 894 s	1128 s 1082 s 1001 s 890 s	1094 m 1019 s 913 m

Table 1 *continued*

No	Assignment	Vibrational frequency (cm^{-1})*				
		Chrysotile a	Chrysotile b	Crocidolite	Amosite	Anthophyllite
3	Silicate chain vibration			777 vs 727 w 692 m 655 m	774 vs 702 vs 637 vs	781 m 754 w 669 vs
4	Cation-oxygen vibration (Mg-O vibration modes for chrysotile or Fe-O vibration modes for amphiboles)	606 s, br 439 s 410 m 305 m	605.5 s, br 484 s, br 434 s 404 m	542 m 503 m 444 s 405 w 320 m	447 m 480 w 425 m 330 w	500 w 455 m

*vs = very strong, s = strong, m = medium, br = broad, w = weak

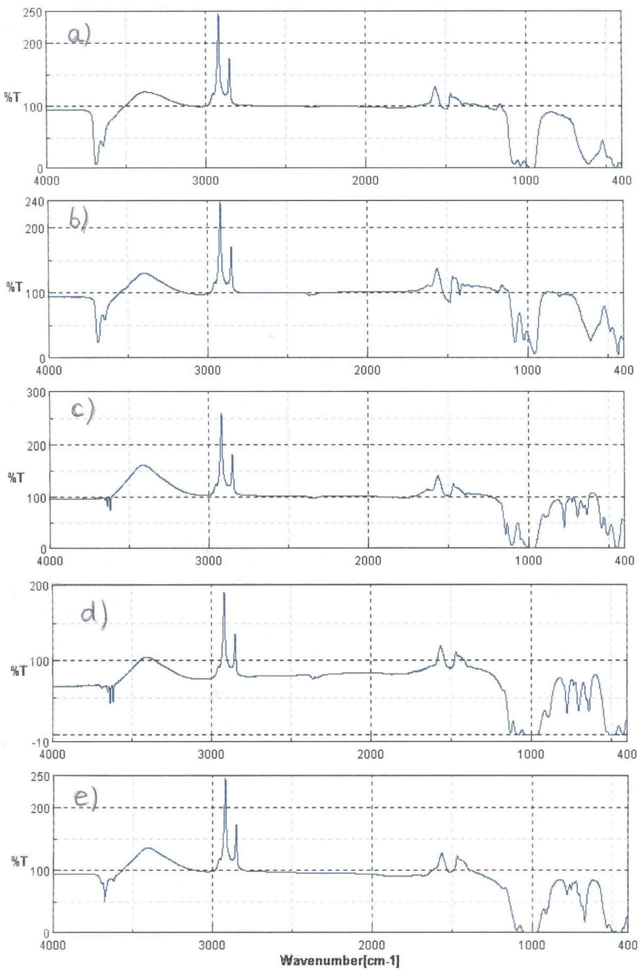

Fig. 1 *FTIR spectra of U.I.C.C. standard asbestos samples:*
a. chrysotile a; b. chrysotile b; c. crocidolite; d. amosite; e. anthophyllite.

Although KBr intensively absorb below 400 cm^{-1}, for chrysotile, crocidolite and amosite the frequencies situated in the range 400-300 cm^{-1} can be used.

Asbestos identification by the infrared technique involves the correlation and comparation of absorption bands in the spectrum of an unknown sample with the known absorption frequencies for types of bands in the spectra of U.I.C.C. standard asbestos samples.

Significant for the identification are intensity (weak, medium or strong), shape (broad or sharp) and position (cm^{-1}) in the spectrum.

In this work, all samples taken from the two investigated technological processes showed the presence of chrysotile asbestos in the occupational environment.

Fig. 2 shows FTIR spectrum of a sample in the occupational environment in the technological process of manufacturing of asbestos gaskets in comparison with U.I.C.C. standard chrysotile spectrum.

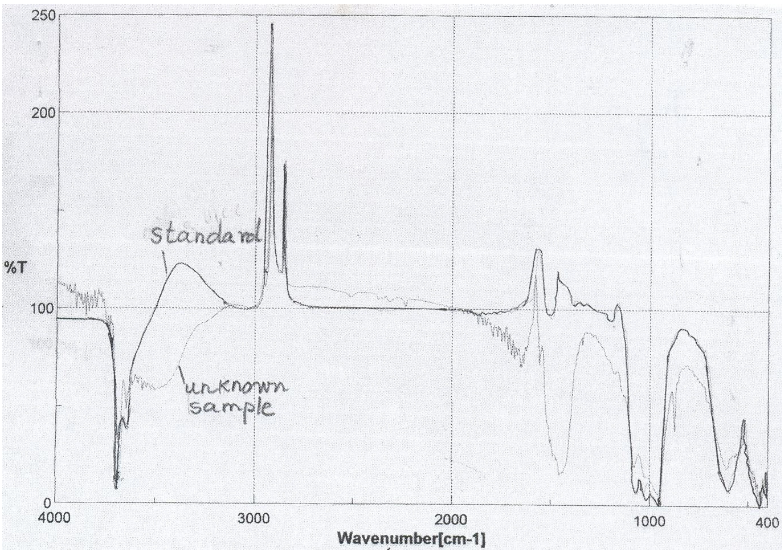

Fig. 2 *FTIR spectrum of a sample in the manufacturing of asbestos gasket process in comparison with U.I.C.C. standard chrysotile asbestos spectrum*

As is illustrated in Fig. 2, in the unknown sample spectrum six characteristic absorption bands of asbestos must be present in order to be sure of asbestos presence in this sample.

FTIR spectra also furnish information regarding the fibre structure changes or chemical composition due to thermal, mechanical or acid treatment of asbestos during the technological processes.

Interpretation of asbestos infrared spectra has to be attentive done due to possible interferences (talc, kaolinite, brushite, bremenite and chlorites) [4,8,13-15]. The use of a resolution of 4 cm^{-1} in this work proved to be appropriate for a good separation of the bands in the spectra.

Conclusion

FTIR spectroscopy represents a developmental, rapid-screening method, for use in determining the presence of asbestos in the occupational environment. The procedure can be successfully applied to different bulk asbestos materials. This method fulfils the request of public institutions and private companies for an appropriate qualitative determination of all types of asbestos in the occupational environment.

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