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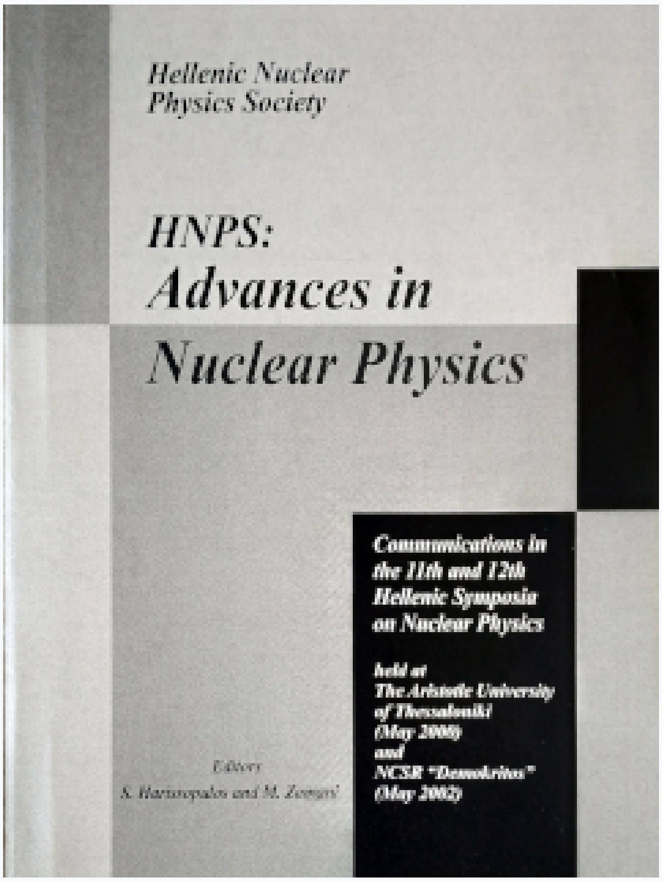

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C. A. Papachristodoulou, K. G. Ioannides, K. C. Stamoulis, C. N. Pafilis

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A study on the effect of wall paint emulsions on radon diffusion

C.A. Papachristodoulou*, K.G. Ioannides, K.C. Stamoulis, C.N. Pafilis

Nuclear Physics Laboratory, The University of Ioannina, 451 10 Ioannina, Greece

Abstract

Experiments have been carried out to study the effectiveness of several wall paints in preventing radon diffusion when applied on several substrates. Several products, widely used in the greek building industry have been tested and results related to different types of paint emulsions are presented.

1. Introduction

During the last two decades there has been increasing scientific interest in the effects of indoor air quality on health. Of particular concern is radon and its decay products, which are now recognized as important indoor pollutants (Alter et al 1987). The usual pathway of ^{222}Rn entry into homes is through the floor and walls adjacent to the surrounding soil. Several methods are currently applied to remedy this situation, which include plugging cracks, avoiding uncovered soil in crawl spaces and taking special care in the construction of basements. Building materials are also identified as a source of indoor radon, since they often have a high content in radionuclides (Papastefanou et al 1984, Pakou et al 1994). It has been postulated (Yu et al 2000) that covering materials, such as wallpaper, plaster or paint, would potentially prevent radon exhalation and reduce its accumulation inside buildings. However, several covering materials were found to increase indoor radon concentration due to their radium content. The biased data available in the literature concerning the effectiveness of commercial paints in reducing radon emanation from walls, have motivated the present study.

2. Materials and methods

2.1 Experimental setup

A special chamber was designed to study radon diffusion through different paint emulsions, applied on various filters. As shown in fig. 1, the chamber consists of two

* E-mail: xpapaxri@cc.uoi.gr

equal halves, upper and lower, which are sealed air-tightly after the filter has been placed between them. A ^{226}Ra source of 100 Bq is placed in the lower half and radon diffusing through the filter to the upper half is monitored by a semiconductor particle detector situated on top of this half. The detector is specially designed for continuous air monitoring (CAM-PIPS Canberra) with an active surface area of 300 mm^2, operating under a 25 V voltage.

2.2 *Experimental procedure and spectra analysis*

Four different types of paint, summarized in table 1, were applied as coatings on either polyethylene (PE) or normal Whatman filters. The build-up of radon in the upper half of the experimental chamber was determined by subsequent spectra, acquired every 10^4 s for a 3 days period. A typical alpha-particle spectrum of the CAM-PIPS detector is depicted in fig. 2, in which the two peaks attributed to the polonium isotopes (^{218}Po $t_{1/2}$ =3.05 min, ^{214}Po $t_{1/2}$ = 69 μs) produced during radon decay are marked. Each of the spectra is analyzed for the ^{218}Po peak (see fig. 3, experimental). Since the particular isotope is short lived compared to ^{222}Rn ($t_{1/2}$ = 3.82

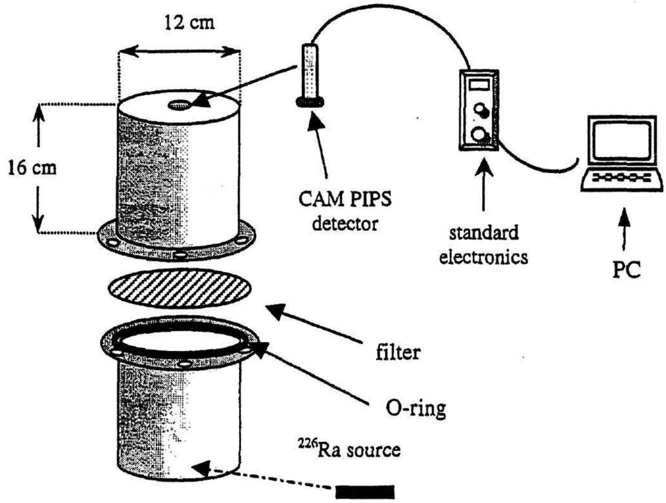

Fig. 1: Schematic diagram of the radon chamber.

d) the two radionuclides reach an equilibrium state soon after the beginning of measurement. Therefore, the final ^{222}Rn levels are predicted by fitting the Bateman equations of radioactive decay to the experimental data of ^{218}Po build-up (see fig. 3, fit).

Table 1: Paint emulsions used in the present study.

Plastic	Copolymer base emulsion, for application on internal/external surfaces
Acrylic	Concrete cement paint, for application on internal/external surfaces
Water-paint	Emulsion for application on internal surfaces
Black bitumen	Waterproof coating for application to iron, concrete, cement and other building materials

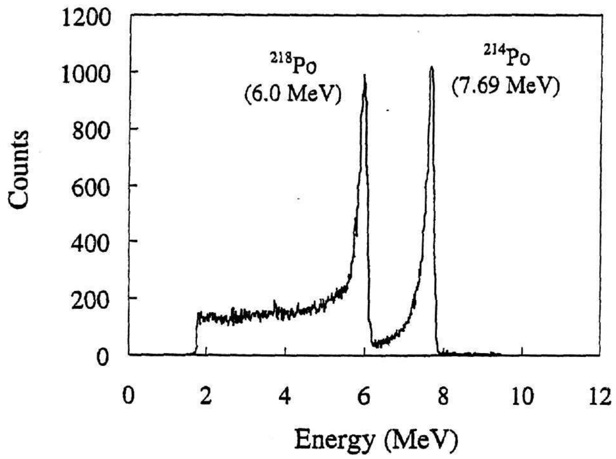

Fig. 2: Spectrum obtained by the CAM-PIPS detector.

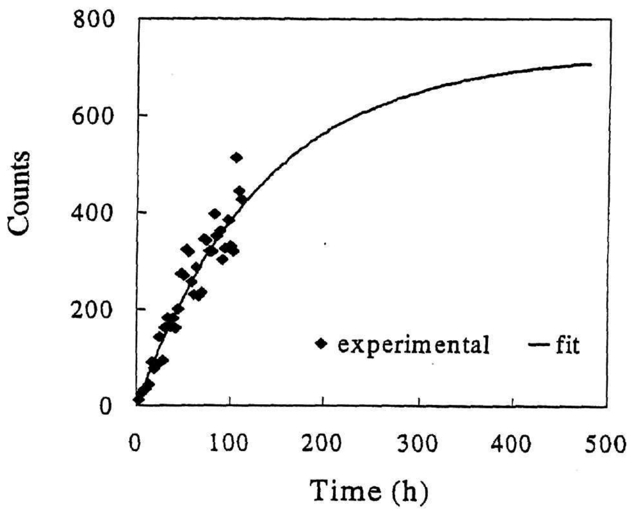

Fig. 3: Determination of ^{222}Rn build-up in the experimental chamber. The time evolution of ^{218}Po decay, measured by subsequent spectra during the 3 d period, is used to calculate radon levels at the equilibrium state.

3. Results and discussion

The effect of a single layer (~100 g m^{-2}) of paint on PE filters is illustrated in fig. 4. The results are given as the fraction, *f*, of the radon activity accumulated when a paint coating is applied on the PE filter to the one accumulated in the presence of the untreated PE filter. As shown in fig.4, application of water-paint allows ~90% of radon to diffuse in the counting chamber, while only 7-9% of radon is able to diffuse after application of either plastic, acrylic or bitumen paint. In contrast to the latter three emulsions, water-paint leaves the pores of the filter practically unsealed and therefore allows radon diffusion. The above results led us to conclude that the effectiveness of the paint emulsion is higher once the coating succeeds in extensively covering the porous surfaces of the walls.

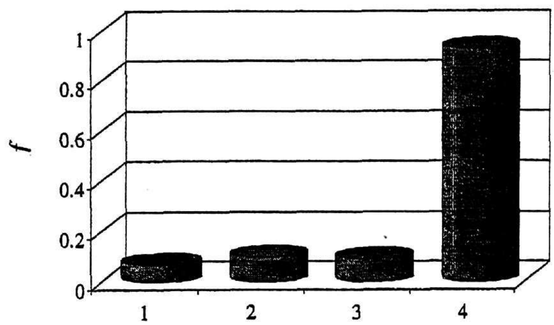

Fig.4: Fraction, *f*, of ^{222}Rn diffusing in the counting chamber in the presence of paint coatings on the PE filter. 1: plastic emulsion, 2: black bitumen, 3: acrylic emulsion, 4: water-paint.

The effect of additional layers of coating on the decrease of radon mitigation has also been tested. For this purpose, 1 to 3 layers of plastic paint were applied on normal Whatman filter. The data shown in table 2 confirm that application of multiple layers can completely suppress radon accumulation in the counting chamber. Attention should nevertheless be drawn to the fact that a minor fault in the continuity of the coating results in the undisturbed diffusion of the gas through the filter.

Table 2: Effect of multiple layers of plastic paint applied on normal Whatman filter

Number of layers	Fraction of ^{222}Rn diffusing in the counting chamber
1	0.75
2	0.63
3	0.04

4. Conclusions

The results presented in this study, although preliminary, reveal the ability of paint coatings to satisfactorily reduce radon emanation from the coating substrate. Our work currently proceeds to the study of more commercially available wall cover materials and wall paints, the most effective of which will also be tested to real buildings.

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