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Report on Radon Permeability of a Plastic Coating Sample

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1. Preliminaries

From November 9th to November 29th 2004, the delivered sample of the plastic coating material for floors **„SILIKAL" (test plate SILIKAL RU727+R62/C+R72)** (thickness d=3,9 mm) was investigated with respect to its Radon permeability via using a two-chamber-system with two parallel running radon monitors. Design and assessment of the test measurements follow the usually accepted standard procedures (see for instance [1], [2], [3], [5]), where materials are called "radon-proof" (in the so used sense), if the obtained diffusion length L is not greater than the third part of the material's thickness d. For a great number of "radon-proof" foils with a customary thickness (2,0 mm), quantities of the diffusion length L less than 0,67 mm and consequently of diffusion coefficients $D = \lambda * L^2$ less than 10^{-12} m²/s with respect to Radon-222 are published. Thus for materials of such kind, this range of the parameters above is some times requested as essential property in different calls for quotation. For the present material sample (test plate of approximately DIN A4 size), these properties were investigated. In the following, the quantity $\lambda = 2{,}10014 * 10^{-6}$ s^{-1} denotes the so-called decay constant with respect to Radon-222.

2. Measurement Method and Interpretation

In a sealing up procedure, the foil sample is inserted in a two-chamber-system, such that each of the surfaces of the foil area S is exposed to the ambient air in exactly one of the two chambers. In a primary closed circuit, a source delivering Radon-222 produces an accumulating Radon activity concentration C_1 such that a stabilised level is generated in the primary chamber. This concentration is continuously measured by a Radon-Monitor RM 2000 and the results are saved with a time grid T. In a secondary closed circuit, a Radon-Thoron-Monitor RTM 2010-2 measures simultaneously an accumulating Radon activity concentration C_2 in the secondary chamber where the results are saved with the same time grid T. A continuous air circulation in each of the two circuits is realised by the pumps integrated in the mentioned measurement devices produced by "SARAD Environmental Instruments" in Dresden. The interpretation of the measurement data taken for the stationary phase (constant gradient of diffusion in the membrane) follows the theory of diffusion (see [4]).

3. Diffusion Length and Diffusion Coeffizient

After measuring from November 9th to November 29th 2004, the following data (time grid T 60 min) are available:

d (Thickness of the sample):	3,9	10^{-3} m (mm)
f (Rate of emanation of the Radon source)	0,00617	Bq/s
C_1 (Primary Radon activity concentration)	> 91.000	Bq/m³
C_2 (Secondary Radon activity concentration)	< 30	Bq/m³
S (Size of the exposed / exhalating foil area)	0,785398	10^{-2} m² (dm²)

As result of calculations (see [4]), the following values of the quantities of interest are obtained:

L (Radon diffusion length)	0,45463	10^{-3} m (mm)
D (Radon diffusion coefficient)	0,43407	10^{-12} m²/s

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4. Resuls of the Investigation

The obtained Radon diffusion coefficient D ($0{,}43 \cdot 10^{-12}$ m²/s) is smaller than the level of 10^{-12} m²/s, i.e., it holds:

$$D < 10^{-12} \text{ m}^2/\text{s};$$

the calculated diffusion length L (0,455 mm) is clearly smaller than a third (1,3 mm) of the sample's thickness d (3,9 mm) and therefore

$$L < d/3.$$

Consequently, the submitted material sample can be called **„radon-proof" in the described sense.**

The investigations of the **given sample** (straight from the factory) were performed with a great carefulness. For a validity and correctness of the statements with respect to this product generally, del credere liability is not assumed.

Concerning an (eventual) large area use of this material, for instance as sealing foil under the basement of buildings, it should be pointed out, that the intended radon insulation effect essentially depends on the circumstances of the special installation (e.g. connection between foil two neighbouring foil layers, gaps for water and power supply etc.).

Remark: Possibly, the investigated material possesses better Radon-reducing properties than those which were achievable by the used measurement methods. In this sense, the values above could be interpreted as upper bounds of these quantities ("conservative estimates").

5. References

[1] Radon-Handbuch Deutschland. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Bonn, und Bundesamt für Strahlenschutz, Berlin (Herausgeber), September 2001.

[2] Radongeschütztes Bauen. Informationsblatt der Beratungsstelle für Radongeschütztes Bauen in Schlema; Sächsisches Landesamt für Umwelt und Geologie, Radebeul (Herausgeber), März 1994.

[3] Keller, G.; Hoffmann, B.: The radon diffusion length as a criterion for the radon tightness. Print, Institute of Biophysics, University of Saarland, Universtätsklinik, Homburg/Saar, Germany, 1998.

[4] Fernandez, P.L.; Quindos, L.S.; Sainz, C.; Gomez, J.: A theoretical approach to the measurement of radon diffusion and adsorption coefficients in radon-proof membranes. Preprint, Faculty of Medicine, University of Cantabria, Santander, Spain; submitted for publication in Nucl. Instr. Meth. (Series B), August 2003.

[5] Grantz, M.; Mehner, H.-C.: Resistance of technical foils against diffusion of the noble gases Ar and Rn. ENOR III – Enhanced Naturally Occurring Radioactivity, International Conference, embedded in the 3rd Dresden Symposium on Radiation Protection, Dresden, March 3-7, 2003.

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