

Test report 2016091901e

Determination of the radon diffusion coefficient and the radon diffusion length of RONDO und RONDO Base wallcollar made of a TPE mixture

Date of test cycle: 2016-07-27 to 2016-07-18

This report includes 5 pages including cover sheet.

1. Description and preparation of the material

It is a TPE mixture for preparing the RONDO and RONDO Base wallcollar. The client supplied flat elements of the material, which were prepared for the application in the test system. The thickness of the material is 7.5 mm.

2. Test equipment

The test is performed in accordance with the norm draft DIN ISO 11665-10 (Measurement of radioactivity in the environment - Air: Radon 222 - Part 10: Determination of diffusion coefficient in waterproof materials using activity concentration measurement, August 2013).

The test specimen is placed between two chambers. In the source chamber, a radon source provides a steady production of radon gas and in the measuring chamber, the change of the radon concentration, caused by a possible radon flow through the material, is measured.

A drawing of the test equipment is presented in the adjacent figure.

V_Q = volume of the source chamber = 0.2 m^3

V_M = volume of the measuring chamber = 0.006 m^3

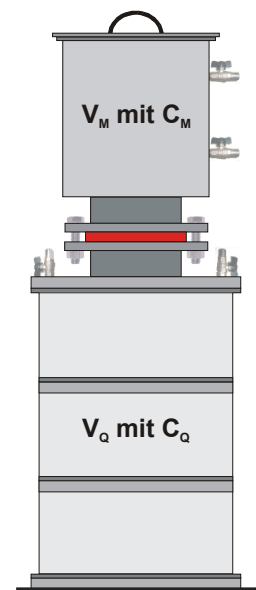
C_Q = steady state radon concentration in source chamber (Bq m^{-3})

C_M = steady state radon concentration in measuring chamber (Bq m^{-3})

To find the steady state radon concentrations the following one-dimensional differential equation for radon diffusion has to be solved:

$$\frac{\partial c(x,t)}{\partial t} = D \frac{\partial^2 c(x,t)}{\partial x^2} - \lambda c(x,t) = 0$$

with



D = radon diffusion coefficient ($\text{m}^2 \text{s}^{-1}$),

$c(\mathbf{x}, \mathbf{t}) = c(\mathbf{x})$ = radon concentration in the material (Bq m^{-3}),

λ = decay constant of radon-222 (0.0000021 s^{-1}).

According to the steady-state radon concentrations and radon fluxes into and out of the membrane in both chambers, the diffusion coefficient for radon in the tested membrane material can be evaluated from the following expression:

$$\cosh\left(\frac{d}{L}\right) = \frac{C_Q}{C_M} \left[1 - \frac{1 - \left(\frac{C_M}{C_Q}\right)^2}{\frac{V_Q}{V_M} \left(\frac{f}{\lambda V_Q C_Q} - 1\right) + 1} \right]$$

with

d = thickness of the material (0.0075 m)

L = diffusion length (m) with $L = \sqrt{\frac{D}{\lambda}}$.

f = radon production rate of the source (Bq s^{-1})

The steady state radon concentration in the measuring chamber will be fitted through non linear regression modelling based on the measured radon concentration.

3. Measurement and results

All measuring instruments (AlphaGuard, RadonScout) are calibrated at the Federal Office for Radiation Protection, Berlin.

The following radon concentrations (\pm uncertainty) have been observed:

source chamber	$C_Q = 134\,000 \text{ Bq m}^{-3} \pm 10 \%$
measuring chamber	$C_M = 1\,400 \text{ Bq m}^{-3} \pm 15 \%$

Based on these values the following parameters can be calculated (range taking into account the above mentioned uncertainties):

radon diffusion coefficient	$D = 4.33 \text{ E}^{-12} \text{ m}^2 \text{ s}^{-1}$ (3.94 E ⁻¹² – 4.78 E ⁻¹² m ² s ⁻¹)
radon diffusion length	$L = 1.44 \text{ mm}$ (1.37 – 1.51 mm)

Concerning the so-called „radon tightness“ country-specific regulations have to be considered.

4. Comments

The results are only valid for the tested specimen. The specimen are no longer usable. The measurements were conducted under normal laboratory conditions. The testing was performed according to the specifications made by the client.

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Bonn, 2016-09-21

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