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Test report 2019080201e

Determination of the radon diffusion coefficient and the radon diffusion length of an insulating coating „Rasco 2K PMBC classic“

Client:	Rasco Bitumentechnik GmbH Imkerweg 32 b D - 32832 Augustdorf
Order:	2018-12-17
Date of test cycle:	2019-07-02 to 2019-07-23

This report includes 5 pages including cover sheet.

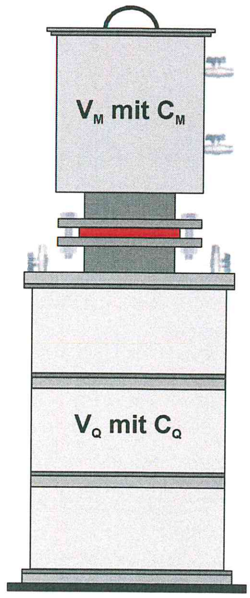
1. Description of the material

It is a two component, polymer-modified, fibre-reinforced bitumen thick coating (PMBC). The contractor supplied plates (HDF, thickness: 3 mm, permeable for radon), which were coated by the client with the material. The thickness of the material is 3.0 mm.

2. Test equipment

The test is performed in accordance with the Technical Specification ISO/TS 11665-13 (Measurement of radioactivity in the environment - Air: radon 222 - Part 13:Determination of the diffusion coefficient in waterproof materials: membrane two-side activity concentration test method; 2017). 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 ($m^2 s^{-1}$),

c(x, t) = c(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

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 (± uncertainty) have been observed:

source chamber	$C_Q = 151\ 000$ Bq $m^{-3} \pm 10$ %
measuring chamber	$C_M = 2\ 000$ Bq $m^{-3} \pm 15$ %

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

radon diffusion coefficient	**D = 7.60 E^{-13} m^2 s^{-1}** (6.88 E^{-13} – 8.44 E^{-13} m^2 s^{-1})
radon diffusion length	**L = 0.60 mm** (0.57 – 0.63 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 measurements were conducted under normal laboratory conditions.

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Bonn, 2019-08-02

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