Sealant for Cable Penetrations

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Introduction

The cable feedthroughs in the deck have potential leak points and short radon diffusion paths which require that some sealant be poured into the cable wells to prevent mine air from entering the blanket gas. The requirements for the sealer are:

(i) Stops radon diffusion and leaks.

(ii) Self levelling; liquid enough to fill all the crannies but not so much that it would drip through any tiny cracks on to the PSUP below.

(iii) Takes long enough to set to allow bubbles to escape.

(iv) Bonds to all surfaces sufficiently to take casual pulls on the cables without breaking the seal.

(v) Doesn't cause dangerous fumes while setting.

Permeability to Rn

Our reduction factor goal for Rn is $N_D/N_U \approx 0.4 \times 10^{-5}$ (where indices refer to "down" and "up", *i.e.* below and above the deck).

$$\frac{N_D}{N_U} \approx \frac{kA}{\lambda l V_D}$$

k: permeability

A: area of short diffusion paths, estimated to be 0.1 m^2.

λ: decay rate, 2.1×10^{-6} s^{-1}.

l: thickness of radon barrier over A, nominally 1 cm.

V_D: gas volume below deck, 57 m^3.

Solving this for the nominal thickness gives $k = 4.8 \times 10^{-11}$ m^2/s, or $k = 4.8 \times 10^{-7}$ cm^2/s.

Dow Corning Firestop

For a while we settled on Dow Corning 2003 firestop as it is nice to work with and fulfills requirements (ii)-(v). However two tests by Jaime Bigu [1] showed that it did not comply with (i). Jaime noted that all silicone rubber-based products were poor radon barriers. The measured permeability was 4.75×10^{-5}cm^2/s. We would need a 1 m thickness!

Acrylic Sealers

A paper on radon sealing in homes [2] claimed that acrylic based sealers were good radon barriers. I obtained some commercial Mono material, but found it did not comply with (ii)-(iii); I suspect other caulks will in this respect be the same.

Epoxies

A paper by Bigu *et al.* "Permeability of Several Materials to ^{222}Rn", lists a set of Oxyguard [3] epoxy floor coverings as consistently the best radon barriers:

Oxyguard 100, 50% solid, fast setting, $k = 3.5 \times 10^{-8}$ cm^2/s (used as initial sealer).

Oxyguard 205, 100% solid, slow setting, $k = 1.2 \times 10^{-7}$ cm^2/s (pinholes suspected).

Oxyguard 305, 100% solid, slow setting, $k = 3.5 \times 10^{-8}$ cm^2/s.

Thus the thickness required over short diffusion paths is (assuming the better numbers) 0.7 mm or (for the worse number) 2.5 mm.

Unfortunately the material doesn't readily wet the feedthrough materials, so we would have to fill the wells to a depth of at least 2 cm to fill beyond the critical parts of the feedthrough. I recommend filling to 3 cm to buy a factor of 10 in safety.

I note that in mixing these binary compounds, it is possible to introduce bubbles which don't have time to rise out before the compound sets. This may be origin of the high number for 205 and can by eliminated by careful procedures. Compound 100 is rather smelly as it has 50% solvent content. The others seem to meet all requirements.

More tests: check diffusion numbers; check for cracking in large volumes.

Costs: \$10 + GST per litre for 105, \$20 for 205, \$24.50 for 305, based on total of 300 l.

I recommend the use of either 200 or 300 (clear versions of the grey 205 and 305), pending further checks as listed above. The clear material will allow quality control and the fixing of potential problems *in situ*.

[.sno.ft]oxyguard.tex

[1] "Permeability properties of firestop sample without plastic films to ^{222}Rn, 94/07/04

[2] R. L. Fleischer, "Permeability of Caulking Compounds to ^{222}Rn", Health Physics **62** (1992) 91

[3] B.M.S. Mfg. Inc., Concord ON, (905) 660-9657