Letter/Attachment for GTCC EIS Scoping Comment #68

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BASIC PROPERTIES OF NuCap™ SEALER/MATRIX

Manufactured by Dow Corning Corporation

Russian/Kurchatov Institute Test Data 1998-2000

Parameter	NuCap Sealer, Matrix and Grout
Porosity	Non-porous monolith
Density	1.2 – 1.6 g/cm^3
Region of temperature stability	-60 — +330 °C
Basic color (The color can be changed depending on the purpose of the material)	From light-gray to white and beige undertone
Transparency	None
Region of thermal stability	-60 to +330 °C
Heat conductivity factor (from 20 to 200 °C)	From 1 to 3.5 W/m· °C
Durability at low temperature	No cracks after 50 temperature cycles from +20 to –196 °C and back.
Thermal expansion index (from 20 to 160 °C)	(1.5-2*)·10^{-4} 1/K *** irradiated to 390 Mrad**
Combustibility	Does not burn and does not support burning
Ash content after heat treatment at a temperature above 1100 °C	51.4 %
Resistance to gamma-radiation	The material keeps its macrostructure and basic properties up to a minimum absorbed dose of 10 Grad
Radiolysis parameters, the intensity of gas emission	V = (0.8-1.0)·10^{-9} cm^3/g·s at dose rates of 12 – 500 rad/s
Resistance to alpha- and beta-radiation	The material keeps its macrostructure and basic properties up to an absorbed dose of 10 Grad
Criticality safety role	Up to 0.5 % of boron (B_4C) can be used as filler.
Residual induced activity after irradiation	Induced activity is absent after irradiation by any kind of radiation.
Influence of the irradiation on the change of physical and chemical properties	The material starts to lose its elasticity at an absorbed dose >200 Mrad. The tensile strength at a dose of 10 Grad has increased by 3-4 times.

BASIC PROPERTIES OF NuCap® MATERIAL

Modulus of elasticity in compression	180 kg/cm^2		
Ultimate strength at tensile failure	20 kg/cm^2, minimum		
Residual deformation 24 hrs after release of compression load	Compression: Exposure time at Compression: Parameter:	50% 6 Minutes 4.5%	25% 20 hours 0.5%
Relative elongation	30 %, minimum		
Adhesion strength - shearing - tearing	 18 – 23 kg/cm^2 16 – 23 kg/cm^2 The character of the tear is cohesive		
Shock resistance	50 kg/cm^2, minimum.		
Strength of chemical bounds	Si-O-Si – 89.3 kcal/mole, minimum.		
Resistance to leaching: In weak acids In weak alkalis In the water	HCl – 5-6%, HNO_3-4.7-6.4%, HF – 1% (1100h) NaOH – 0.6 % Distilled H_2O No leaching		
Resistance to a corrosive gas (ozone, No_2)	Excellent		
Resistance to organic solvents	The material is resistant to acetone, benzene, kerosene, carbon tetrachloride		
Sorption ability	$K_d = 0.01$		
Gas diffusion Hydrogen	 $K_d = 1.5 \cdot 10^{-8}$ cm^2/s		
Thermal ageing	The loss of mass for 100 years is 0.06 %, max.		
Hydrophobness	Hydrophobic		
Sound absorption ω = 250 – 6300 decibel/m	III class according to the State standard GOST 23499 $\alpha = 0.2 – 0.3$		
Dielectric permeability, ε	2.9 – 3.6		
Penetrability	The material fills chinks, cracks and openings with a gap of more than 1 mm.		

NuCap™ Sealer Product – USA Testing Data

Overview – Coupons of U.S.-produced NuCap™ Sealer were subjected to a series of tests designed to illustrate its performance under a wide variety of environments. The tests were performed by independent certified laboratories under a Quality Assurance program approved by the Nuclear Regulatory Commission. Following is a summary of key parts of the test results.

Product Performance Testing

1. **Chemical Resistance** (ASTM D 3912) – In this test three coupons were placed in each of twenty separate chemical solutions (60 coupons total) for a duration of 30 days each. The solutions and their pH were: N_2H_4 (9.47), Borax (9.15), deionized water (7.93), Boric acid (5.31), Sulfuric acid (1.25), H_2O_2 (2.74), Na_3PO_4 (10.71), Aluminum Sulfate (3.14), Calcium Nitrate (6.12), $CrCl_2$ (2.94), $FeCl_2$ (2.07), $MnSO_4$ (7.15), NaOH (11.21), $Pb(NO_3)_2$ (5.37), Si_2Cl_4 (0.36), Na_2CO_3 (10.43), $NaNO_2$ (8.54), $ZrSO_4$ (1.04), K_3PO_4 (13.84) and NH_4F (7.34). All sixty coupons were completely intact at the conclusion of the test with no peeling, delamination or blistering.
2. **Permeability** (ASTM E 96) – The average water vapor transmission (WVT) rate of three coupons was 3.9 $g/m^2/24$ hrs, well under the most stringent requirements.
3. **Adhesion** (ASTM 3359) – All six coupons met criteria for 5A rating, the best possible, with no peeling or removal of material.
4. **Weathering** (ASTM G 26) – All samples easily passed with either a 4.5 or 5 on the 5-point scale. The 4.5 indicated slight discoloration but no material deterioration.
5. **Salt Spray** (ASTM B 117) – The test coupons showed no blistering, delamination or evidence of corrosion.
6. **Ignitability** (ASTM D 2863) – None of the NuCap™ Sealer coupons charred at less than 31% oxygen and there was no ignition.
7. **Leachability** (ANS 16.1) – Three coupons were tested with each of three aqueous solutions of cesium, cobalt and strontium salts. There was no detectable leaching of any of the salts.
8. **Aging** – Several coupons were thermally treated over a range of temperatures and times to establish a mass loss relationship that could be correlated to natural aging. Using a process developed by the Kurchatov Institute of Russia and approved by the American Polymer Institute, coupons were then thermally conditioned to a predicted age of 171 years. The aged coupons were then subjected to chemical resistance, tensile/elongation and adhesion tests. The chemical resistance test was per ASTM D3912 again, but with only the NaOH solution; the coupons showed negligible coating surface deterioration, with no peeling or blistering. The tensile/elongation test showed an increase in strength to an average of 332 psi and a decrease in elongation to an average of 97%. The adhesion results were a rating of 5A, the highest, with no peeling or removal of material. Taken in total, the aged coupons showed a continued excellent resistance to chemical attack, a great elasticity and tremendous adhesive capability.
9. **Flame Spread** (ASTM E 84) – The flame spread index was 15 and the smoke development value was 275, both well under criteria for indoor application.

Product Definition Testing

1. **Linear Shrinkage/Coefficient of Thermal Expansion** (ASTM C 351) – The average of four specimens was 1.30% linear shrinkage and 0.0002 in/in/°F.
2. **Steady State Heat Flux** – The average of three specimens was 0.265 Btu/hr ft °F.

3. **Volatile Organic Content** – The tested value was 36 g/l, well under most site requirements of 350 g/l. No toxic or explosive gasses were measured.
4. **Tensile Strength/Elongation** (ASTM D 412) – The average tensile strength was 201 psi and elongation was 176%. These values show excellent elastomeric behavior.
5. **Compressive Strength** (ASTM D 695) – The five coupons had an average compressive strength of 911 psi at yield and an average compressive modulus of 2918 psi.
6. **Water Absorption** (ASTM D 570) – The average of five coupons was 0.4% by weight, significantly less than most elastomers.

Conclusions – These results combine with previous test and demonstration data from Russia to show that NuCap™ Sealer has unique properties:

- **Very High Resistance to Degradation due to Irradiation (Tested to 10 Gigarads without deterioration)**
- **Very High Resistance to Degradation due to Aging**
- **Very High Resistance to Degradation due to Chemical Exposure**
- **Very Low Permeability**
- **No Measurable Leachability**
- **No Toxic Components**
- **Fire Resistant and able to withstand transient temperature spikes to 1100°F**
- **Extremely Adhesive to practically any Surface, even Rusty, Dirty, Wet or Underwater Environments**

These properties make NuCap™ Sealer ideal for providing a stable environmental barrier inside OR outside of containers, including patching leaks. NuCap™ Sealer is also an ideal macroencapsulant and is a stable waste form being submitted for approval to existing disposal sites.

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