HLWYM HEmails

From: Tae Ahn
Sent: Monday, April 10, 2006 6:27 AM
To: David Pickett; vjain@cnwra.swri.edu; Keith Compton; Richard Codell; Timothy McCartin
Subject: (3) RE: New TAD Table
Attachments: Table_Release Rate Calculations 3 22 06.wpd

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Sorry, please disregard the previous two.

Vijay, in my earlier Table with Tim, we made distinction between (i) pure carbonate solution and (ii) silicate (or Ca solution) water. What you did was based on the pure carbonate solution, which I did also in the earlier Table. Other factors which we need to make distinctions include the flow rate effect and the iron effect. Again, those were listed previously too. We did not make clear about the iron effect though in the last meeting. Also, in the last meeting we only talked about the effect of internals. I'll talk about it on the phone and individually.

>>> Vijay Jain <vjain@cnwra.swri.edu> 04/07/06 2:25 PM >>>
Tim and Tae,

I did some sensitivity analyses using DOE SNF model (alkaline region). The results are as follows.

1. At 400 ppm HCO3 (6.6 mmol), 0.2 oxygen fugacity, the spent fuel fractional rate changed from 1.9E-7 /d to 6.4E-7 /d when the temperature was increased from 25 C to 75 C. This was done at the lowest surface area of 5E-8 m2/mg.

2. At 50 C, 0.2 oxygen fugacity, the spent fuel fractional rate changed from 3.4E-7 /d to 3.8E-7 /d when the HCO3 concentration was changed from 200 ppm HCO3 (3.3 mmol) to 600 ppm (9.9 mmol). This was done at the lowest surface area of 5E-8 m2/mg.

3. At 50 C, 400 ppm HCO3 (6.6 mmol), the spent fuel fractional rate changed from 2.3E-7 /d to 3.6E-7 /d when the pO2 was changed from 0.05 to 0.2. This was done at the lowest surface area of 5E-8 m2/mg.

4. When the surface area was changed from 5E-8 m2/mg to 4E-6 m2/mg (this is DOE range for Surface Area), the SNF fractional release rate increased from 3.6E-7 /d to 2.5E-5 /d at 50 C, 0.2 oxygen fugacity and 400 ppm HCO3. This showed the biggest effect.

Surface area is the key to the fractional release rate.

Vijay

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Mail Envelope Properties (s439faec.068)

Subject: (3) RE: New TAD Table
Sent Date: 4/10/2006 6:27:20 AM
Received Date: 4/10/2006 6:29:25 AM
From: Tae Ahn

Created By: Tae.Ahn@nrc.gov

Recipients:
"David Pickett" <dpickett@cnwra.swri.edu>
Tracking Status: None
"vjain@cnwra.swri.edu" <vjain@cnwra.swri.edu>
Tracking Status: None
"Keith Compton" <Keith.Compton@nrc.gov>
Tracking Status: None
"Richard Codell" <Richard.Codell@nrc.gov>
Tracking Status: None
"Timothy McCartin" <Timothy.McCartin@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	2258	4/10/2006 6:29:25 AM
Table_Release Rate Calculations 3 22 06.wpd	9172	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received: Follow up

Release Rate Calculations for Different Water Conditions (3/22/06)

Inputs / Results	J-13 Water, ANL Drip Test	J-13, Silicate Water, Immersion Test	Carbonate Water, Accelerated Flow-through	Corrosion Products, Iron/Iron Oxide
pH	4.2 to 9.0	7.5 to 8.5	5, 8, 10	
Temperature (°C)	90 (25)	25 and 50	25 and 50	
Surface Area (m^2/MTU)	46, 456, 3900	220	3900	
Degradation Rate (mg/m^2-day)	3.8 (avg.)	0.01 - 4.0	0.3 - 30	
Release Rates (fraction/year)	25°C 6.31E-5, 6.31E-4, 5.4E-3 (x1.95 for 50°C) 90°C (2.58E-4, 2.53E-3)	25°C 8.03E-7, 3.2E-4 50°C (1.57E-6, 6.24E-4) pH factor x5 to pH=4.5	25°C 4.27E-3 50°C 8.33E-3	x 0.1 Others: (a) partial cladding x0.1 more and (b) drip rate x (0.01 to 0.1)
grain boundary inventory (~ 2 %) is likely control the release in most SNF particle tests: conservatism				
Np solubility (kg/m^3)	E-9 to E-2	E-7 to E-5	Np_2O_5 3E-4 to 3E-1 [NpO_2 1.1E-4 to 5.9E-1 at pH = 4.5 to 7]	

Pu Colloid Concentration (kg/m^3)		6.9E-5		(a) ionic strength of the inpackage chemistry may decrease the conc.: max 0.05 M (fixed) (b) iron colloids may increase the conc.
Flow rate (liters/year)	1.5 to 150, 1.5E4 (focused)			
Solub. Release Rates (fraction/year) - Np	(2.05 to 205) x(E-13 to E-6) 2.05x (E-9 to E-2) (focused)	(2.05 to 205) x(E-11 to E-9) 2.05x (E-7 to E-5) (focused)	Np Oxide (6.15 to 615) x(E-8 to E-5) 6.15x (E-4 to E-1) (focused)	
Pu Colloid Rel. Rates (fraction/year)		<u>Initial</u> 8.88(E-10 to E-8) 8.88E-6 (focused) <u>Steady State</u> 8.88(E-13 to E-11) 8.88E-9 (focused) <u>Iron Colloid (mono-layer of Pu)</u> 8.88E-12 to 1.78E-9 (8.88-17.8)E-8		

- Cladding protection failure time: ~ 200,000 yrs
- WP failure time: ~ 200, 000 years, interval: ~ 20,000 yrs
- SF dissolution Time: several 10,000 yrs
- Solubility Release: Oxide model or high flow rate give ~ 50,000 yrs or less (e.g., 50)
- Pu colloid release: longer than any of these except focused flow