HLWYM HEmails

From: Osvaldo Pensado
Sent: Wednesday, July 12, 2006 6:36 PM
To: Xihua He
Subject: RE: Drip shield corrosion rate

Let me think and digest the data and I will go back to you.

-----Original Message-----
From: Xihua He [mailto:xhe@cnwra.swri.edu]
Sent: Wednesday, July 12, 2006 4:27 PM
To: opensado@cnwra.swri.edu; 'Vijay Jain'
Cc: 'Yi-Ming Pan'
Subject: RE: Drip shield corrosion rate

Osvaldo,

I reviewed the general corrosion rate of titanium grade 7 and other titanium alloys. I will give you my assessment on the corrosion rate of drip shield in our TPA code.

The lower corrosion rate values in TPA 4.1j (4.3E-8 and 8.6E-8 m/yr) are mainly based on the long term laboratory test data reported in CNWRA 2001-03 (Figure 4-7 and 4-9). The corrosion rate decreased with time. It is very possible that the upper value (1.7E-6 m/yr) is based on short term measurement results in Figure 4-7.

The upper value (1.7E-6 m/yr) in TPA 4.1j is high compared to what reported in the literature. I will list some of the literature data:

1. Blackwood et al. (1988) reported a maximum rate of 10-20E-6 m/yr for a pH = 1 acidified solution and < 1-2E-6 m/yr for pH ~ 2 solution. It is very unlikely to get solution with such low pH in Yucca Mountain Repository.
2. In Metal's handbook, 9th Edition, Volume 13, the reported titanium grade 7 general corrosion rates in 62% $CaCl_2$ at 150°C, 10% and 30% $FeCl_3$, and saturated $MgCl_2$ boiling solutions are nil (pp. 705-706). These solutions are very aggressive.
3. DOE data including titanium grades 7 and 16 (General and Localized Corrosion of the Drip Shield. Rev. 2, 2004): 3.8E-8 m/yr to 3.2E-7 m/yr. For titanium grade 7 the corrosion rate is 3.8E-8 m/yr to 5.0E-8 m/yr
4. Hua and Gordon (2004) reported the corrosion rate of titanium Grade 7 in BSW-12 at 60°C to 105 °C is 2.03E-7 to 6.6E-7 m/yr.
5. For titanium grade 24/29 supports, Schutz (2003) reported that the general corrosion rate is 4-5 times of that of titanium grade 7.
6. German data for titanium Grade 7 after 3.5 yrs exposure to Q-brine
   90°C - 6E-8 m/yr
   170°C - 4E-8 m/yr
   200°C - 1.5E-7 m/yr

By analyzing literature data, the highest corrosion rate in Yucca Mountain relevant conditions are in the order of 10-7 m/yr. So, I agree with you to lower the upper value in the old version of TPA code while keep the lower values the same. But the upper value in the new version (2.6E-7 m/yr) may be a little bit low. How about increase it slightly to bound what reported in the literature?

If you want to have further discussion on this, please let me know. I would be happy to have a discussion.

References:
Bechtel SAIC. General and Localized Corrosion of the Drip Shield. Rev. 2, 2004
Blackwood, D.J., L.M. Peter, and D.E. Williams. "Stability and Open Circuit Breakdown of the Passive Oxide Film on Titanium." Electrochimica Acta, 33, pp. 1143-1149. 1988.

Hua, F. and G. Gordon. "Corrosion Behavior of Alloy 22 and Ti Grade 7 in a Nuclear Waste Repository Environment." Corrosion, Vol. 60. pp. 764-777. 2004.
Scuutz, R.W. "Platinum Group Metal Additions to Titanium: a Highly Effective Strategy for Enhancing Corrosion Resistance." Corrosion. Vol. 59. pp. 1043-1057. 2003.

Thanks,
Xihua

-----Original Message-----
From: Osvaldo Pensado [mailto:opensado@cnwra.swri.edu]
Sent: Monday, April 10, 2006 5:45 PM
To: Xihua He; Vijay Jain
Cc: Yi-Ming Pan; ddunn@swri.org
Subject: Drip shield corrosion rate

Xihua,

I need your help to come up with revised values of the drip shield corrosion rate. I will give you some history

In TPA 4.1j we had triangular(4.3E-8, 8.6E-8, 1.7E-6) m/yr. The reference I have is CNWRA 2001-03; however, I have not been able to trace those values. Sean Brossia was around that time and he helped selecting this range of corrosion rates.

The upper value looks like some literature value or some short term measurement; I do not know for sure.

I TPA 5.1beta, I increased the corrosion rates by 2, to account for the fact that corrosion could occur in the underside of the drip shield. Thus, the revised corrosion rates became
triangular(8.6E-8, 1.72E-7, 3.4E-6) m/yr

The upper value is problematic as it predicts that the drip shield would fail in few thousands of years. The distribution of corrosion rates has a pretty broad right tail, high corrosion rates are sampled too frequently, and this causes the mean failure time to be of the order of 12,000 years. In contrast, the measurements of the passive current density indicate that the most likely time failure is of the order of 90,000 years (assuming corrosion in both sides of the drip shield).

I have temporarily shaved the upper end of the distribution. The revised distribution is

triangular(8.6e-8, 1.72e-7, 2.6e-7) m/yr

The only criterion I applied was that the distribution was symmetric.

We will transmit the TPA code on April 15. There is no time to refine the distribution before that time, but we can do it at a later time, and I am requesting your help.

In the new version of the TPA code, the failure time of the DS by corrosion defines the time-window of susceptibility for WP-DS seismic interactions. After the DS has corroded, the seismic interactions stop. Therefore, now it is conservative to assume a long DS life. In other words, the DS has become a negative barrier.

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From: Osvaldo Pensado

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"Xihua He" <xhe@cnwra.swri.edu>
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