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Subject: Cumulative distribution for STEEL:CORRMCO2

Based on the data from corrosion experiments performed by Roselle (2013), a cumulative distribution for the STEEL: CORRMCO2 has been constructed, as described below. Although Roselle proposed to use a Student-t distribution to describe CORRMCO2, in order to address a comment received from the EPA regarding the CRA-2014 (Letter from J. Edwards, USEPA to J. Franco, DOE, Transmitting Fourth Set of Completeness Comments Related to the 2014 WIPP Compliance Recertification Application, Response 4-C-2. July 30, 2015. EPA Docket EPA-HQ-OAR-2014-0609-0024, ERMS 564885), we found that it was appropriate to construct a cumulative distribution of values for the CORRMCO2 parameter from Roselle's data.

Because there is a predicted value of 3.14 ppm CO_2 in the gas phase when in equilibrium with WIPP brines (Brush and Domski 2013), corrosion rates based solely on 0 ppm CO_2 experiments may not completely reflect iron corrosion under WIPP conditions. Therefore it is appropriate to also consider data from corrosion experiments performed under conditions with nonzero CO_2 concentrations. The data available from Roselle (2013) include corrosion rates for CO_2 concentrations of 0 and 350 ppm. Corrosion rates observed for experiments with 350 ppm CO_2 and 1atm could be representative of corrosion rates in the repository after closure.

Corrosion rates observed for experiments at 350 ppm CO_2 and 1 atm are considered as possibly relevant to WIPP only for the purpose of representing corrosion of steels inundated in WIPP-relevant brine and subjected to lithostatic repository pressure of roughly 70 atm or greater. Aqueous CO_2 concentration in WIPP conditions of 3.14 ppm CO_2 in the gas phase and 70 atm of pressure is roughly comparable to the aqueous concentration of CO_2 that would have been present in the experiments at 350 ppm CO_2 and 1 atm. Inclusion of these data does not imply that gas phase concentrations of CO_2 in the WIPP would exceed the equilibrium value of 3.14 ppm given by Brush and Domski (2013).

We have aggregated the observed rates for experiments at 0 ppm and 350 ppm CO_2 to form a distribution for STEEL:CORRMCO2 (Figure 1). The revised distribution considers all non-negative corrosion rates reported by Roselle (Roselle 2013) as equally likely, and also adds a rate of 0 m/s to acknowledge the possibility that steel surfaces may passivate, as was done in the CCA. Implementing the distribution displayed in Figure 1 as a change to the parameter STEEL:CORRMCO2 does not affect the screening argument, decision, or the implementation of gas generation (pressurization) within PA models.

WIPP:4.2.1:PA:QA-L:RECERT:563151

The relevant inundated corrosion rate data in Roselle (2013) comprises 128 data points, 64 for samples tested at 0 ppm carbon dioxide (CO_2) and 64 for samples tested at 350 ppm CO_2. The 350 ppm CO_2 data set was reduced to 60 samples by excluding nonphysical, negative corrosion rates. The corrosion rates from Table A-1 of Roselle (2013) were converted from units of μm/yr to m/s and sorted in ascending order, with equal weight assigned to each corrosion rate, resulting in a cumulative distribution function (CDF) (see attached Excel spreadsheet for the detailed calculations). There are a total of 125 values, including the value of 0 m/s lower bound limit assigned to the zeroth percentile of the CDF. The resulting CDF can be used as a cumulative distribution to describe the STEEL: CORRMCO2 parameter (Table 1). The cumulative distribution described by the sample of corrosion rates is selected. This distribution is appropriate to describe uncertainty in STEEL:CORRMCO2 because this distribution represents the range of variability in corrosion rates presented by the available data. Statistics for the CDF are shown in Table 2.

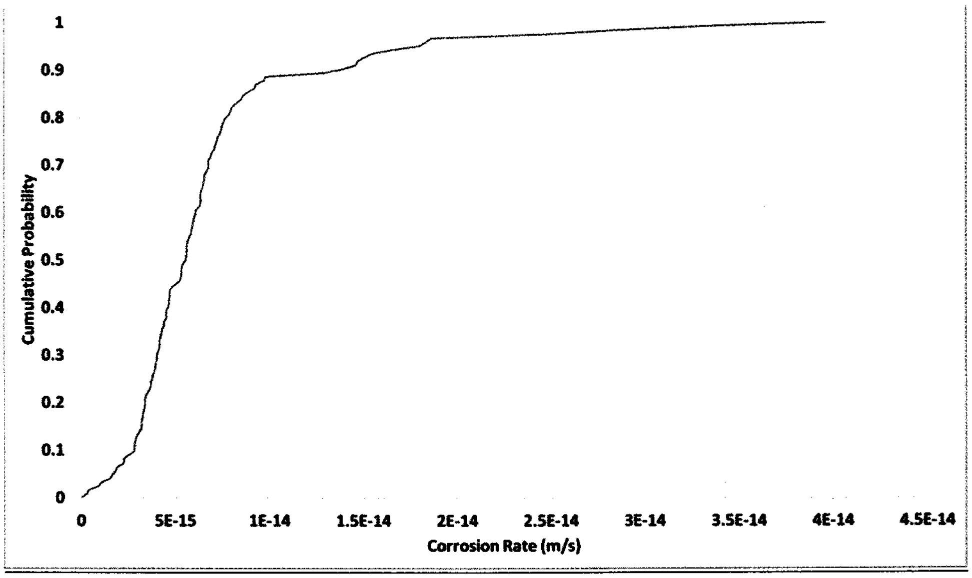

Figure 1. Cumulative distribution function for STEEL:CORRMCO2.

Table 1. CDF data for the STEEL:CORRMCO2 parameter that describes inundated iron corrosion rates.

Rank	Value (m/s)	Cumulative Probability
1	0	0
2	3.17098E-16	0.008065
3	3.80518E-16	0.016129
4	9.19584E-16	0.024194
5	1.07813E-15	0.032258
6	1.52207E-15	0.040323
7	1.64891E-15	0.048387
8	1.83917E-15	0.056452
9	1.90259E-15	0.064516
10	2.2514E-15	0.072581

11	2.2514E-15	0.080645
12	2.47336E-15	0.08871
13	2.82217E-15	0.096774
14	2.85388E-15	0.104839
15	2.85388E-15	0.112903
16	2.88559E-15	0.120968
17	2.94901E-15	0.129032
18	3.07585E-15	0.137097
19	3.20269E-15	0.145161
20	3.2344E-15	0.153226
21	3.2344E-15	0.16129
22	3.26611E-15	0.169355
23	3.29782E-15	0.177419
24	3.36124E-15	0.185484
25	3.39295E-15	0.193548
26	3.39295E-15	0.201613
27	3.39295E-15	0.209677
28	3.48808E-15	0.217742
29	3.61492E-15	0.225806
30	3.71005E-15	0.233871
31	3.71005E-15	0.241935
32	3.77347E-15	0.25
33	3.80518E-15	0.258065
34	3.9003E-15	0.266129
35	3.96372E-15	0.274194
36	3.99543E-15	0.282258
37	4.02714E-15	0.290323
38	4.02714E-15	0.298387
39	4.09056E-15	0.306452
40	4.15398E-15	0.314516
41	4.18569E-15	0.322581
42	4.18569E-15	0.330645
43	4.2174E-15	0.33871
44	4.28082E-15	0.346774
45	4.31253E-15	0.354839
46	4.40766E-15	0.362903
47	4.40766E-15	0.370968
48	4.5345E-15	0.379032
49	4.5345E-15	0.387097
50	4.5345E-15	0.395161
51	4.66134E-15	0.403226
52	4.66134E-15	0.41129
53	4.69305E-15	0.419355

54	4.72476E-15	0.427419
55	4.72476E-15	0.435484
56	4.8516E-15	0.443548
57	5.13699E-15	0.451613
58	5.29554E-15	0.459677
59	5.32725E-15	0.467742
60	5.35895E-15	0.475806
61	5.35895E-15	0.483871
62	5.42237E-15	0.491935
63	5.58092E-15	0.5
64	5.61263E-15	0.508065
65	5.64434E-15	0.516129
66	5.64434E-15	0.524194
67	5.64434E-15	0.532258
68	5.67605E-15	0.540323
69	5.77118E-15	0.548387
70	5.86631E-15	0.556452
71	5.89802E-15	0.564516
72	5.92973E-15	0.572581
73	5.96144E-15	0.580645
74	6.02486E-15	0.58871
75	6.08828E-15	0.596774
76	6.11999E-15	0.604839
77	6.31025E-15	0.612903
78	6.37367E-15	0.620968
79	6.37367E-15	0.629032
80	6.37367E-15	0.637097
81	6.40538E-15	0.645161
82	6.4688E-15	0.653226
83	6.53222E-15	0.66129
84	6.56393E-15	0.669355
85	6.56393E-15	0.677419
86	6.65906E-15	0.685484
87	6.7859E-15	0.693548
88	6.7859E-15	0.701613
89	6.7859E-15	0.709677
90	6.91273E-15	0.717742
91	6.94444E-15	0.725806
92	7.10299E-15	0.733871
93	7.1347E-15	0.741935
94	7.22983E-15	0.75
95	7.26154E-15	0.758065
96	7.38838E-15	0.766129

97	7.4518E-15	0.774194
98	7.48351E-15	0.782258
99	7.57864E-15	0.790323
100	7.67377E-15	0.798387
101	7.86403E-15	0.806452
102	7.95916E-15	0.814516
103	8.02258E-15	0.822581
104	8.24455E-15	0.830645
105	8.52993E-15	0.83871
106	8.62506E-15	0.846774
107	8.91045E-15	0.854839
108	9.22755E-15	0.862903
109	9.32268E-15	0.870968
110	9.73491E-15	0.879032
111	9.83004E-15	0.887097
112	1.29059E-14	0.895161
113	1.39206E-14	0.903226
114	1.46499E-14	0.91129
115	1.47451E-14	0.919355
116	1.50939E-14	0.927419
117	1.55378E-14	0.935484
118	1.66476E-14	0.943548
119	1.80429E-14	0.951613
120	1.836E-14	0.959677
121	1.86454E-14	0.967742
122	2.46068E-14	0.975806
123	2.82851E-14	0.983871
124	3.29465E-14	0.991935
125	3.96055E-14	1

Table 2. Statistics for the CDF of STEEL:CORRMCO2.

Mean	6.76E-15
Median	5.58E-15
St. Dev.	5.84E-15
Min.	0.00E+00
Max.	3.96E-14

<u>References</u>:

Brush, L.H. and P.S. Domski. 2013. Prediction of Baseline Actinide Solubilities for the WIPP CRA-2014 PA. Sandia National Laboratories, ERMS 559138.

Roselle, G.T. 2013. "Determination of Corrosion Rates of Gas Generation Rates from Iron/Lead Corrosion Experiments, AP 159, Rev. 1" Analysis Report, January 23, 2013. Carlsbad, NM: Sandia National Laboratories. ERMS 559077.