Open Ended Problem #9

Nuclear Industry
Group work okay, Due 11/27/23 at beginning of class
(Don't be afraid to "Google" for reasonable assumptions; just provide references!)

Davis Besse Plant "Near" Accident

Rather than a movie, we have a real life open-ended problem, which illustrates the challenge of corrosion. The boric acid primary coolant leaked out through a faulty control rod drive shaft seal, and then evaporated, leaving concentrated boric acid on the carbon steel reactor pressure vessel. Over the course of 6 years (3 fuel cycles, or in other words the frequency of the inspection period), this acid had completely eaten through the 8 inches of carbon steel, leaving only the 3/8" of the stainless steel liner. Since the pressure in a reactor pressure vessel is 2250 psi, this could have easily resulted in a catastrophic accident had the shutdown and inspection been delayed by only a couple of weeks. Considering the significance of this near-miss situation, I want you to calculate a couple of things: 1) what was the corrosion penetration rate for this accident? 2) What concentration does the boric acid need to reach in order for this corrosion to be spontaneous?

1) What is this problem actually asking for? What is the final value you are being asked to find?

2) Draw sketches or plots that indicate the actual problem scale and scope.

3) a) What physical laws apply to this problem?
   b) Indicate equations, correlations, and/or formulae that can model these laws.
   c) What are the potential limitations of these equations?

4) What assumptions should be made to utilize the equations/correlations/formulae listed in part 3b?
        a) List ALL the assumptions that you need to in order to solve the problem.

        b) Justify your assumptions (**references**, reasoning, judgment, common sense, etc.)

5) What are the physical properties (list assumed or referenced values) used in this problem?

6) What was the corrosion penetration rate for this accident?
   What concentration does the boric acid need to reach in order for this corrosion to be spontaneous and rapid?

7) Verify your answer... Does it look reasonable? Anything odd about the calculation?
        a) How much would it cost to inspect this reactor vessel more frequently? (Hint: look at electricity replacement costs for 2 extra days of inspection each outage, which is normally 18 days)
        b) How much would it cost just to make the 8 inch thick vessel out of stainless steel instead of carbon steel?
        c) Is there a different protection that would have worked? At what cost?
        d) Put together a cost-effective approach to prevent a Davis-Besse like accident.