ChemE 378, Assignment #29

Special Problems 7-9

SP7. You are assigned by your employer to design a better baffle for use in 1 N sulfuric acid contaminated with various oxidizing agents. It has been suggested by your boss that you use Type 316 stainless steel, for which you have several polarization curves (see below).

(a) You notice that the potentials on the polarization curves are given versus an "SCE," or Standard Calomel Electrode, and not relative to a Standard Hydrogen Electrode (SHE). Can you use this chart? Explain.

(b) The calomel electrode makes use of the half reaction: $Hg + Cl \rightleftharpoons 1/2\ Hg_2Cl_2 + e^-$
for which the standard half-cell potential (vs. the SHE) is +0.280V. If you needed to, could you convert the potentials in your polarization curves to the SHE scale? Prove it by giving the half-cell potential, relative to the SHE, at which the critical current occurs in 90°C sulfuric acid.

(c) After changing to the SHE scale in Part b, what is the critical current?

(d) You are especially concerned about the effect of three different oxidizing solutions (Corrosive Solutions A, B and C) on your baffle. For each of these solutions, tell whether type 316 SS will be active or passive in 1 N sulfuric acid at 90°C, and give the corrosion current density.

Corrosive Solution A

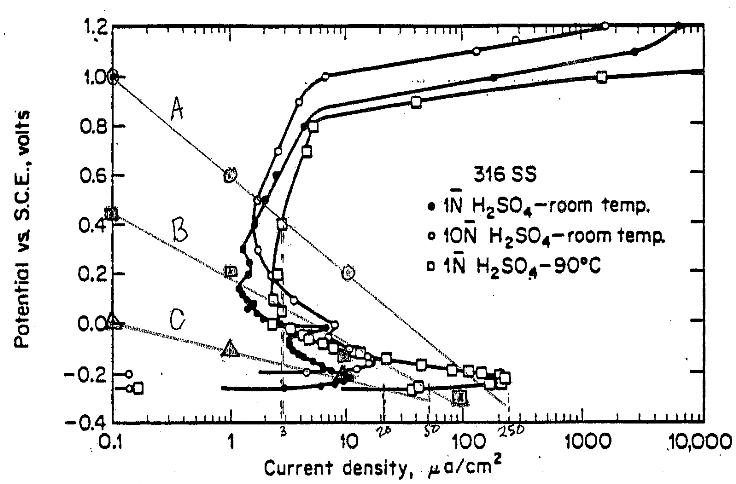
Current density ($\mu a/cm^2$)	0.1	1	10	100
Potential (vs. SCE)	1.0	0.6	0.2	-0.05

Corrosive Solution B

Current density ($\mu a/cm^2$)	0.1	1	10	100
Potential (vs. SCE)	0.45	0.2	-0.5	-0.3

Corrosive Solution C

Current density ($\mu a/cm^2$)	0.1	1	10	100
Potential (vs. SCE)	0.0	-0.1	-0.2	-0.3



(e) Suppose your solid baffle is made of 316 SS, with dimensions 5 x 5 x 0.2 cm. If it were placed in solution A at 90°C, how long would it take to completely corrode the baffle away? (Assume that the specific gravity of 316 SS is 8.02.)

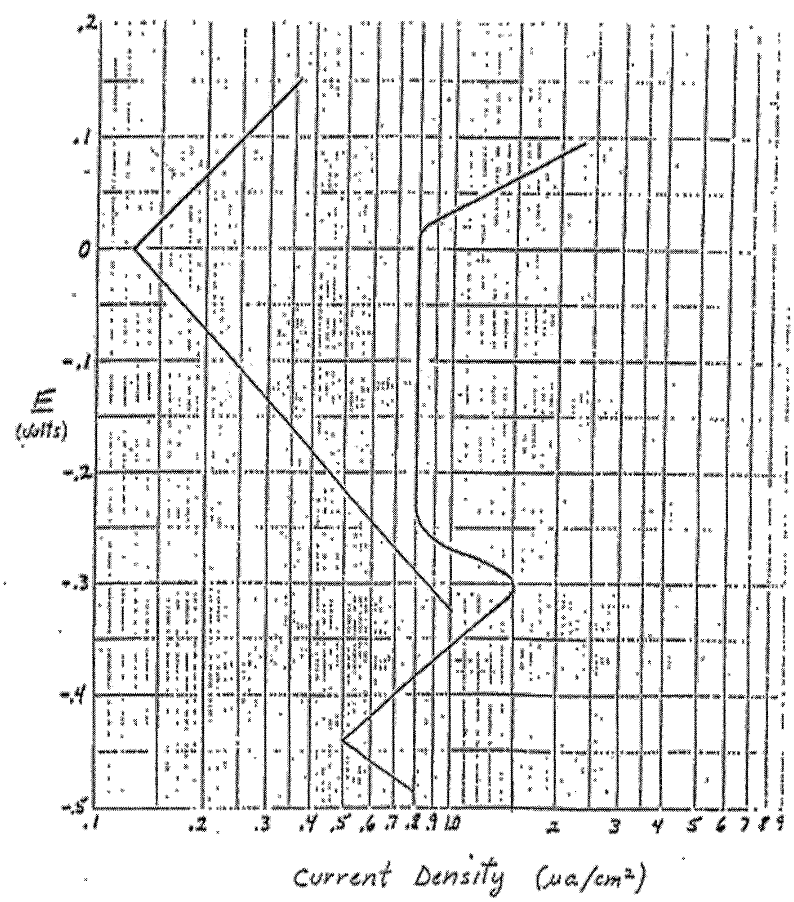
SP8. A rod of a particular stainless steel 18 cm long and 2 cm in diameter is submerged in an acid solution, and the polarization curves for the iron and acid half-reactions are found to behave as shown on the next graph. It is decided to protect the steel using anodic protection (i.e. forcing the steel into the passive range) as provided by external current from a current source device.
a. What minimum current must the device deliver to be able to passivate the metal.

b. What is the minimum current the device must deliver to maintain protection of the steel? (Show your work.)

c. What is the net current that you must buy from the power company if you operate at E = -0.1 V?

d. What is the net power that you will consume to operate at this condition?

e. What will be the initial corrosion rate (in g/y) when the steel is successfully protected? (Assume that the steel has the same density and molecular weight as pure iron.)

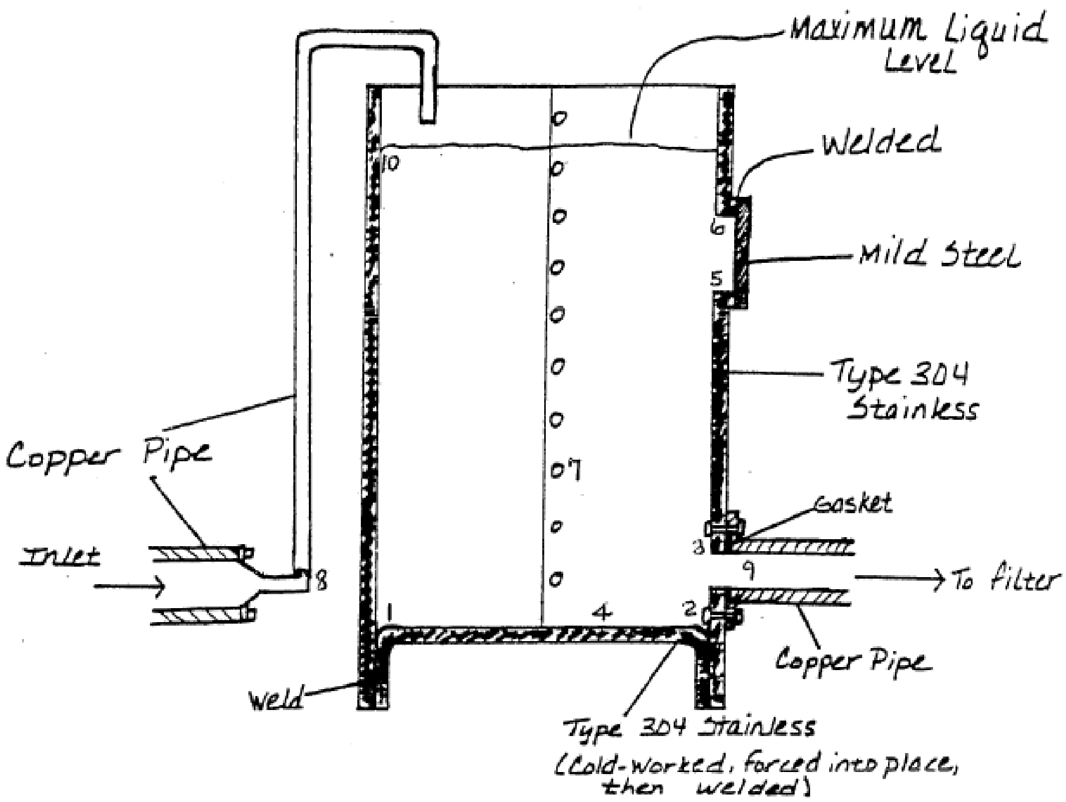


SP9. Corrosion Prevention

a. If two dissimilar metals have to be joined together, what precautions must be observed to reduce the intensity of the attack on a less noble metal?

b. What type of gasket materials would you recommend to prevent corrosion of steel-bolted joints in a petroleum processing plant? Temperature ranges up to 300°C, but little water is present. Give your reasons.

c. The drawing below represents a proposed design for a tank to be used to hold a concentrated aqueous solution of suspended solids in brine which tend to settle out when the liquid slows down in the tank. The numbers on the drawing indicate where this system might develop corrosion problems. Describe the kind of corrosion that could occur at each spot (e.g., erosion corrosion, galvanic corrosion, etc.) Also suggest corrosion prevention or better design at each of these locations. Please give your answers in the space provided below the drawing.



LOCATION #	TYPE OF CORROSION	REMEDY (DESIGN or MATERIALS CHANGE)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		