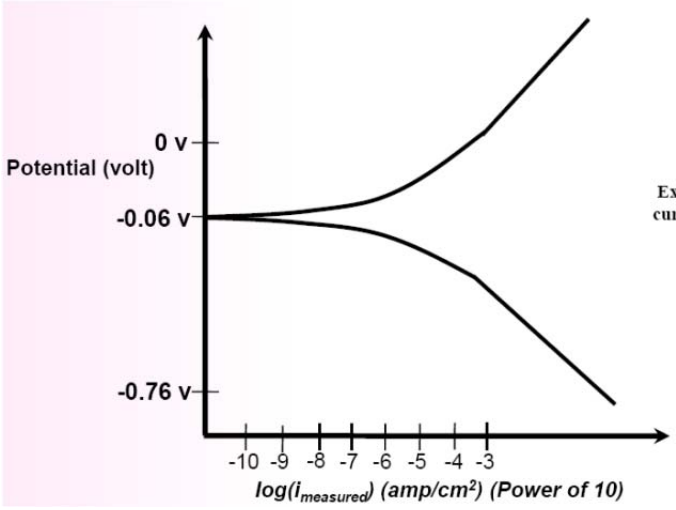
Assignment 8

1. The corrosion rate of a pure iron specimen in deaerated HCl acid is 40 mdd. The corrosion potential is -0.6386 V vs. SCE (saturated calomel electrode, E^0_{SCE} = 0.241 V) in this acid. Find out the pH of the acid. Show that concentration overpotential is linearly related to current density when current density is very small.
   $\beta_c = 0.1$; $i_o^{H+/H2}{}_{(Fe)} = 10^{-7}$ A/cm^2; atomic wt of Fe = 55.85.
2. Show the position on the diagram. (given: $E_{rev} = E_0 = -0.76$ v for Zn (SHE) and $E_{rev} = E_0 = 0$ v for hydrogen (SHE)).



Experimental plot of potential vs. current density (Zinc in pure HCl)

   Show the position of i_0 of anodic and cathodic reactions.
   Show the corrosion current and corrosion voltage.
3. Write major corrosion process as cited in the Figure.

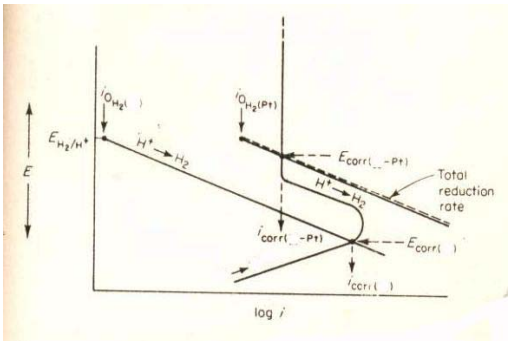
a. 

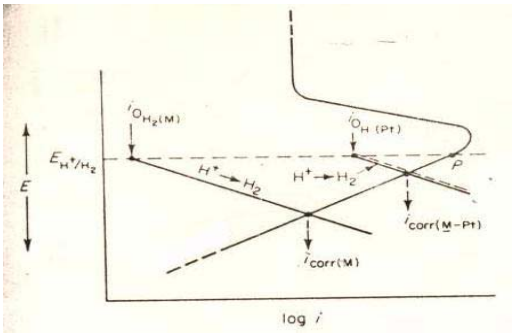
Loosening of side plates at rail joint

b. 

Corrosion at the corner of water Tank

4. Which curve will be applicable for corrosion of Ti and Fe in air-free acid solution if these metals are alloyed with noble metal like Pt.





5. Convert -0.12 V and 0.6 V (on saturated calomel electrode (SCE)) to standard hydrogen electrode (SHE). (E^0 (SCE) = 0.241 V).
6. (a) The corrosion current of a steel specimen in deaerated pure HCl acid is 1.8×10^{-5} amp/cm^2. Calculate the corrosion potential of iron vs. saturated calomel electrode (SCE) in the acid of pH 2.5. β_C is assumed to be 0.1 v/decade and $i^{H+/H2}{}_0$ is 10^{-7} amp/cm^2 for iron. (E_{SCE}=0.241v and T=25^{0}C).

   (b) The $\Delta E/\Delta i$ at low current densities for iron in a given corrosive is 5 mv/micro-amp/cm^2. Calculate the corrosion rate in mdd. Given: Tafel slope for both anodic and cathodic reaction is 0.1 V/decade; atomic wt of Fe = 55.85.
7. (a) Show with proper illustration that anodic protection mechanism is much better than impressed current cathodic protection in terms of economic standpoint in case of active passive metals.

   (b) Write the expression for Butler-Volmer equation.

   (c) Exchange current density for hydrogen reaction is changed from 10^{-6} to 10^{-5} amp/cm^2. Show with proper schematic and label in E vs i (potential vs current density in absolute scale) plot that current density will increase at the same level of overvoltage when exchange current density is changed from 10^{-6} to 10^{-5} amp/cm^2.

8. (a) Draw the possible experimental curve for the situation as shown in Fig. 1.

   (b) Show the change in corrosion rate of a metal showing typical interaction with a cathodic reaction (Fig. 2) as a function of concentration of the oxidizer (position 1 to 7 in the Fig. 2):

   (i) The concentration of the oxidizer first increases from minimum to maximum value gradually.

   (ii) The concentration of the oxidizer decreases to minimum position from maximum value. While decreasing the concentration, the surface of the metal is not disturbed.

   (iii) The concentration of the oxidizer decreases to minimum position from maximum value. While decreasing the concentration, the surface of the metal is disturbed at a concentration corresponding to position 2 in the Fig. 2. (Mark all the points in the corrosion rates vs. concentration plots as per the notations shown in the Fig. 1)

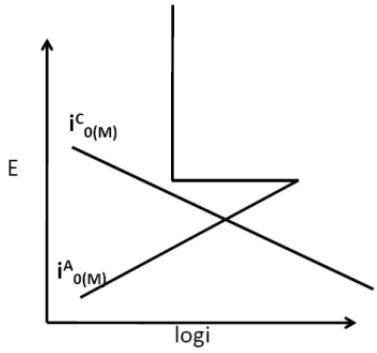


Fig. 1

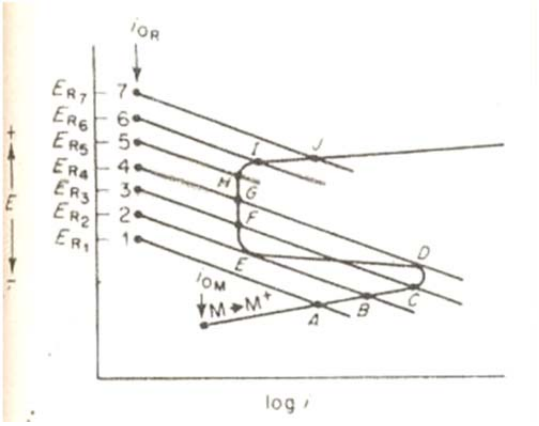


Fig. 2

9. (a) What is Pilling Bedworth ratio (PBR)?

   (b) Calculate the PBR for a metal (M) which forms M_2O_5 oxide.

   (c) What would you think about oxidation resistant of the metal (M) by seeing its PBR ratio? (Data: molecular weight of M_2O_5 = 181.88, specific gravity of M_2O_5 = 3.357 gm/cc, atomic weight of M = 50.94 and specific gravity of M = 6.0 gm/cc.

   (d) A n-type oxide (ZnO) is doped with aluminium. What would be the oxidation resistance of the metal after alloying with Al (show with schematic)?