QFL 1544 e 5614

Lista de Problemas "Transporte"

1. (a) Which three types of mass transport exist in the electrolyte? List the name and describe the mechanism.

    (b) Draw a schematic view of the concentration (c) variation as a function of the distance (x) of the electrode during an electrochemical reaction when only the diffusion occurs as mass transport mechanism. Mark the thickness of Nernst diffusion layer (d).

    (c) Explain why the Nernst diffusion layer is both time and diffusion coefficient dependent.

    (d) The reaction H+ + e- = ½ H_2 may occur at a Pt electrode. A Pt electrode has a surface dimension of 2 cm × 2 cm. The electrolyte is 1 mol/l HCl solution, and the current flowing through the Pt electrode is measured to be 0.8 mA. Calculate the current density (j), and the diffusion flux (J).

2. (a) Calculate the diffusion coefficient, D (m^2/s) for H+ ion in water at room temperature. (μ(H+) = 3.62 × 10^{-3} cm^2/s·V, the viscosity of water η = 1 × 10^{-3} kg/m·s). Then use the Stokes-Einstein equation: $D = RT/6N_A\pi\eta r$ to calculate the effective hydrodynamic radius, r (Å).

    (b) Assume an ideal diluted aqueous electrolyte solution in a very long electrochemical cell. Will a charged particle experience a constant acceleration in the electrolyte due to the electric potential gradient induced by the charged electrode? And why?

3. a) Which condition have to be fulfilled for diffusion limited current

    I. Cx=bulk = 0

    II. Cx=bulk = Cx=electrode

    III. Cx=electrode = 0

    b) What transport mode (migration, diffusion or convection) is affected by the following changes: Multiply answers as well as none of the above are possible

I. Increasing the potential gradient

II. Increasing the concentration gradient

III. Increasing the concentration

IV. Increasing the temperature

V. Increasing the radii of the solvated ion

VI. Changing the density gradient

VII. Changing the solvent of the electrolyte

VIII. Changing the external wires from copper to gold

4. The rotating disk electrode (RDE) rotates with the angular frequency $\omega = 2\pi f$; $(\text{rads}^{-1}) = (2\pi \text{ Hz})$ in solution, drawing up the liquid along the rotation axis and filling it out.

The Nernst diffusion layer can be expressed as

$$\delta_N = 1.61 \cdot D^{\frac{1}{3}} \cdot v^{\frac{1}{6}} \cdot \omega^{-\frac{1}{2}}$$

The current density is defined as

$$J = 0.62 \cdot n \cdot F \cdot D^{\frac{2}{3}} \cdot v^{-\frac{1}{6}} \cdot \omega^{\frac{1}{2}} \cdot c_0$$

where n is the number of electrons involved in the electrode reaction.

Calculate the Nernst diffusion layer and the current density for the disk electrode rotating at 100 Hz for HCl and H_2SO_4 electrolyte solutions. For both electrolytes use kinematic viscosity $v = 10^{-6}$ m^2 s^{-1}. Explain the interest of the rotating disks for electro-analytical application. Diffusion coefficient for H_2SO_4: $D_{H2SO4} = 5.64 \ 10^{-6}$ cm^2 s^{-1}, c = 0.1 mol·dm^{-3}, for HCl: $D_{HCl} = 2.35 \ 10^{-5}$ cm^2 s^{-1}, c = 1.66 mol·dm^{-3}.

5.   a – Write a short description of the meaning of both Fick equations.

   b- If an electrochemical reaction if diffusional controlled, what are the boundary conditions for a finite and infinite systems?.

   c- What is the meaning of finite or infinite systems?

   d- Make a design of the concentration profile for both systems as a function of distance from the electrode and time.