Department of Chemical Engineering **IIT Delhi**

CHL705 Electrokinetic Transport Processes **Term: Aug. 2006**

Max. 50 points
Time 2 hr. **4. 12. 2006**

Major

Answer should be brief and to the point.
Maintain the continuity of the parts of each question

1. Consider a channel flow is formed by an impermeable wall and the flat electrode surface at a distance b = 2 mm apart (width). Air at 25 °C and 1 atm is fed to the cathode electrode of H = 30 (length) cm and the air flow is parallel to the channel walls with a steady velocity of V_m = 3 cm/s. The cathode electrode is 230 μm thick with porosity of 0.4. Determine the maximum current density attainable in accordance with the air transport through cathode when the cathode is not flooded by liquid water.
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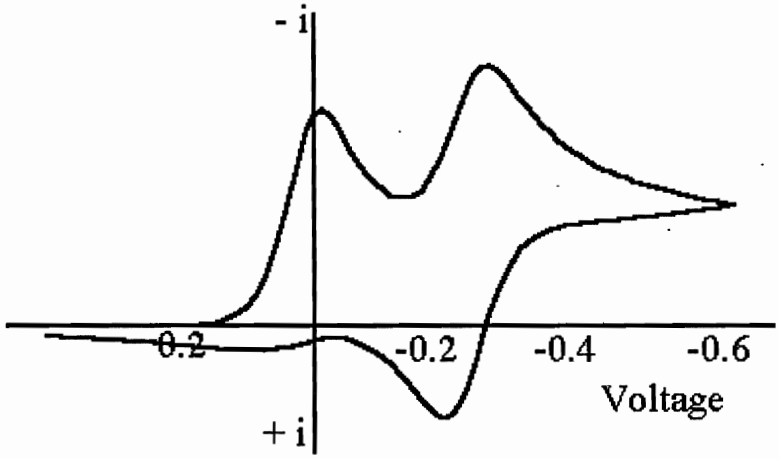
2. An example of an **ECE** 'like' process is shown below.

$$E \quad O + e \rightleftharpoons R$$

$$C \quad R \xrightarrow{k_{ECE}} S$$

$$E \quad S + e \rightleftharpoons T$$

The type of voltammogram recorded in this case is shown below.



Can you explain the behaviour here?
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3. Show that for 1:1 electrolyte in water at 25 °C the following equation (charge density)

$$\sigma = \varepsilon \left(\frac{2kT n_0}{\varepsilon} \right)^{\frac{1}{2}} \left[e^{\frac{ze\psi_0}{2kT}} - e^{-\frac{ze\psi_0}{2kT}} \right]$$

can be rearranged to give

$$\psi_0 = 51.4 \sinh^{-1} \left(\frac{137}{\sigma^0 \sqrt{c}} \right)$$

in which ψ_0 is expressed as millivolts, c is in moles per litre, σ^0 is the area ($A^{0\,2}$) per charge at the surface. Davies (1951) measured the potential across an air-aqueous NaCl interface which carried a monolayer of $C_{18}H_{37}\,N\,(CH_3)_3^{\,+}$. When the quaternary octadecylamine was at pressure corresponding to $\sigma^0 = 85\ A^0$, the following potentials were measured at different concentration of NaCl.

E (mV)	240	280	325	340	380
C_{NaCl} (M)	2.0	0.5	0.1	0.033	0.01

About 200 mV of these potential differences arises from dipole effects at the interface and should be subtracted from each value to give the double layer contribution to the measured potential. Compare these corrected values with the values of ψ_0 calculated by the equation given and discuss the results.

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