CH692 In class w1d2

Problem 1: The flood agglomerate model is introduced to provide a simple picture of a complex porous electrodes that have gas phase reactants, electrolyte, and solid phase electrodes where faradaic reactions occur.

(a) Draw a picture/diagram of a relevant flooded agglomerate system that illustrates the *boundary conditions assumed* the key microscopic physical processes and driving forces (potentials etc.) that the model takes into account.

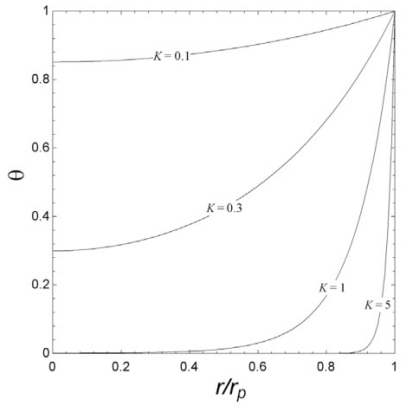
(b) What processes that might be important are not taken into account?

(c) The materials balance equation assumed is:

$$\frac{\partial \varepsilon c_i}{\partial t}^{0} = -\nabla \cdot \mathbf{N}_i - \frac{s_i}{nF}\nabla \cdot \mathbf{i}_2$$

Describe what the assumptions here are and why and when they are likely to be valid. Why is $\nabla \cdot \mathbf{i}_2$ in the equation and how does Fuller and Harb represent it in the differential equation?

(d) The figure below shows dimensionless concentration profiles that result from solving the differential equation. What is *K* conceptually? Describe the shape of the curves below and the dependence on *K*.



Problem 2: A packed bed electrode is used to remove metal ions from solution. The inlet concentration of the metal ions in a supporting electrolyte solution is **0.01 M**, and the desired outlet concentration is **0.0001 M**. The size of the electrode perpendicular to the flow **is 50 cm × 50 cm**, and the volumetric flow rate of the solution to be treated is **50 L/min**. The spherical particles that make up the bed are **0.1 mm** in diameter. The porosity of the bed is **0.55**, and the mass-transfer coefficient is **0.004 cm/s**. The direction of flow is from the front of the electrode toward the back, similar to that seen in the figure below. The reduction reaction is a **three-electron reaction**.

Please calculate

(a) the required thickness of the electrode,

(b) the superficial current density at the front of the electrode closest to the anode,

(c) the relative rates of reaction at the front and back of the electrode.