Chem201 Self Quiz - 7 (Chromatography)

1. Solvent passes through a column in 3 minutes, but solute requires 9 minutes.

   a. Calculate the capacity factor k´

   $$k' = \frac{t_r - t_m}{t_m} = \frac{t_s}{t_m} = \frac{9-3}{3} = 2$$

   b. What fraction of time is the solute in the mobile phase in the column?

   $$\frac{t_m}{t_r} = \frac{1}{3}$$

   c. The volume of stationary phase is one-tenth of the volume of the mobile phase in the column ($V_s = 0.10 * V_m$). Find the partition coefficient, K, for this system.

   $$K = k' \frac{V_m}{V_s} = k' \frac{V_m}{0.1 \cdot V_m} = \frac{2}{0.1} = 20$$

2. The retention volume of a solute is 76.2 mL for a column with V_m = 16.6 mL and V_s = 12.7 mL. Calculate the partition coefficient and capacity factor for this solute.

   $$K = \frac{V_r - V_m}{V_s} = \frac{76.2 - 16.6}{12.7} = 4.69$$

3. What is the electroosmosis?

   Electroosmosis is the bulk flow of the fluid in the capillary caused by migration of the dominant ion in the diffuse part of the double layer toward the anode or cathode.

4. State three different methods to reduce electroosmotic flow.

   a. Lowering the pH so that the charge on the capillary wall is reduced.
   b. Adding fully protonated amino ions ($^{+}H_3NCH_2CH_2CH_2NH_3^{+}$), so that they adhere to the capillary wall and effectively neutralize the charge
   c. Covalently attaching silanes with neutral, hydrophilic substituents to the Si-O^{-} groups on the walls.

5. A particular solution in a particular capillary has an electroosmotic mobility of $1.3*10^{-8}$ m^2/Vsec at pH 2, and $8.1*10^{-8}$ m^2/Vsec at pH 12. How long will it take a neutral solute to travel 52 cm from the injector to the detector if 27 kV are applied across the 62-cm-long capillary tube at pH2? And pH 12?

At pH 2.

$$u_{eo} = \mu_{eo} E = (1.3 \cdot 10^{-8}\, m^2/V\,\text{sec})\left(\frac{27 \cdot 10^3\, V}{0.62\, m}\right) = 5.66 \cdot 10^{-4}\, m/\text{sec}$$

$$t_{migration} = \frac{L_{\det ector}}{velocity\ of\ the\ EO} = \frac{0.52\ m}{5.66 \cdot 10^{-4}\ m/\sec} = 9.2 \cdot 10^{2}\ \sec$$

At pH 12.

$$u_{eo} = \mu_{eo} E = (8.1 \cdot 10^{-8}\ m^2/V\ \sec)\left(\frac{27 \cdot 10^{3}\ V}{0.62\ m}\right) = 3.53 \cdot 10^{-3}\ m/\sec$$

$$t_{migration} = \frac{L_{\det ector}}{velocity\ of\ the\ EO} = \frac{0.52\ m}{3.53 \cdot 10^{-3}\ m/\sec} = 1.47 \cdot 10^{2}\ \sec$$