CBE-521, Fall 2015

Homework No. 2

Due Date: Tuesday, December 2nd, 2015 in class

1. Let the electrophoretic mobility be given by

$$\mu_{ep} = \frac{2}{3}\frac{\varepsilon\varepsilon_0\zeta}{\eta} f_1\ \kappa a$$

The correction function $f_1\ \kappa a$ is given by (Henry)

$$f_1\ \kappa R\ = 1 + \frac{\kappa R\ ^2}{16} - \frac{5\ \kappa R\ ^3}{48} - \frac{\kappa R\ ^4}{96} + \frac{\kappa R\ ^5}{96} - \left[\frac{\kappa R\ ^4}{8} - \frac{\kappa R\ ^6}{96}\right]\exp\ \kappa R \int_{\infty}^{\kappa R} \frac{\exp\ -t}{t} dt$$

Or by the Ohshima approximation

$$f_1\ \kappa R\ = 1 + \frac{1}{2\ 1 + \left[\frac{5}{2\kappa R}\ 1 + 2e^{-\kappa R}\ \right]^3}$$

Using software of your choice plot both Henry and Ohshima's expressions and comment on the agreement/disagreement between them. Is the Ohshima approximation reasonable to use?

2. The electrostatic potential in a slit-shaped channel is

$$\tilde{\Psi} = \tilde{\Psi}_0 \frac{\cosh\left[\kappa\ h/2 - x\ \right]}{\cosh\ \kappa h/2} \approx \tilde{\zeta}\frac{\cosh\left[\kappa\ h/2 - x\ \right]}{\cosh\ \kappa h/2}$$

Calculate the average migration conductivity for $\kappa h = 1$ and $\tilde{\zeta} = 1$.

3. The measured values of electrophoresis mobilities for two different samples are $\tilde{\mu}_{ep} = 3$ and $\tilde{\mu}_{ep} = 5$. The electrolyte is 1:1 type and in both cases $\kappa R = 1$. Since double layer polarization is likely, use the expression

$$\tilde{\mu}_{ep} = \frac{3\tilde{\zeta}}{2} - \frac{6\left[\frac{\tilde{\zeta}}{2} - \frac{\ln 2}{z}\ 1 - \exp\ -z\tilde{\zeta}\ \right]}{2 + \frac{\kappa R}{M}\exp\left(-\frac{z\tilde{\zeta}}{2}\right)}$$

To obtain the zeta potential for both samples.