Environmental Geotechniques - 7718
Assignment # 2

1) room temp. 2×10^{-3} M $AlCl_3$ in water 3:41

$CEC = 120$ meq/100 g

$SSA = 700\ m^2/g$

(5) a) $n_0 = 2 \times 10^{-3} \frac{moles}{litre} \times 6.02 \times 10^{23} \frac{ions}{mole} \times 1000 \frac{litres}{m^3} =$ (2)

$= 1.204 \times 10^{24} \frac{ions}{m^3}$

$$\frac{1}{K} = \left(\frac{\varepsilon_0 D\ kT}{2 n_0 e^2 \nu_i^2}\right)^{0.5}$$

$$= \left(\frac{7.083 \times 10^{-10}\ C^2/Jm \times 4.04 \times 10^{-21}\ J}{2 \times 1.204 \times 10^{24}/m^3 \times (1.602 \times 10^{-19}\ C)^2 \times 3^2}\right)^{0.5}$$ (2)

$= (5.14487 \times 10^{-18}\ m^2)^{0.5}$

$= 2.268 \times 10^{-9}\ m = 22.7\ \text{Å}$ (1) 3:53

(5) b) $\sigma = \Gamma F = \frac{CEC}{SSA} \times F =$

$= \frac{120\ meq}{100\ g} \times \frac{g}{700\ m^2} \times \frac{96.5\ C}{meq} = 0.165 \frac{C}{m^2}$ (1)

$$\sinh\left(\frac{z}{2}\right) = \frac{\sigma}{(8 n_0 \varepsilon_0 D kT)^{0.5}}$$

$$= \frac{0.165\ C/m^2}{(8 \times 1.204 \times 10^{24}/m^3 \times 7.083 \times 10^{-10}\ C^2/Jm \times 4.04 \times 10^{-21}\ J)^{0.5}}$$ (1)

$= 31.43$; $z/2 = 4.14$

$z = 8.28$ (1)

$\psi_0 = \frac{zkT}{\nu_i e} = \frac{8.28 \times 4.04 \times 10^{-21}\ J}{3 \times 1.602 \times 10^{-19}} = 0.0696\ V$ (2)

$\psi_0 = -69.6\ mV$

(5) c) ψ at 10 Å from surface, in mV

$$K = \frac{1}{22.7\ \text{Å}} = 0.04405\ \text{Å}^{-1}$$ (1)

$$e^{z/2} = e^{4.14} = 62.8$$ (1)

$$e^{y/2} = \frac{e^{z/2} + 1 + (e^{z/2} - 1)e^{-Kx}}{e^{z/2} + 1 - (e^{z/2} - 1)e^{-Kx}}$$

$$= \frac{62.8 + 1 + (62.8 - 1)e^{-0.04405 \times 10}}{62.8 + 1 - (62.8 - 1)e^{-0.04405 \times 10}}$$

$$= \frac{63.8 + 39.78}{63.8 - 39.78}$$

$$= 4.312 = e^{1.461}$$

$$y \doteq 2.923$$ (2)

$$\psi = \frac{y kT}{\nu_i e} = \frac{2.923 \times 4.04 \times 10^{-21}\ J}{3 \times 1.602 \times 10^{-19}\ C} = 0.0245\ V$$

(1) $\psi = -24.5\ mV$

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(2) d) $$n_i = n_0 \exp\left(\frac{-\nu_i e \psi}{kT}\right)$$

$$= 1.204 \times 10^{24}/m^3 \exp\left(\frac{3 \times 1.602 \times 10^{-19}\ C \times 0.0245\ V}{4.04 \times 10^{-21}\ J}\right)$$

$$= 2.22 \times 10^{25}\ \frac{\text{ions}}{m^3}$$ (2)

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Assignment #2.

1) e) $D_{water} = 80$ and D for ethyl alcohol = 24.3.

$$\sigma = (8 n_0 \varepsilon_0 D k T)^{1/2} \sinh\left(\frac{\nu e \varphi_0}{2kT}\right)$$

$$\sinh\left(\frac{\nu e \varphi_0}{2kT}\right) = \frac{\sigma}{(8 n_0 \varepsilon_0 D k T)^{1/2}}$$

The surface potential function and surface potential increase as the dielectric constant decreases.
A lower D means less insulating capacity and so the surface potential effect is greater.

$$n_i = n_0 \exp\left(\frac{\nu_i e \varphi}{kT}\right)$$

Since the lower dielectric constant causes a higher surface potential, then more cations will be attracted to the surface as indicated in the above equation.

$$\frac{1}{K} = \left(\frac{\varepsilon_0 D k T}{2 n_0 e^2 \nu^2}\right)^{1/2}$$

The thickness of the double layer decreases as the dielectric constant decreases, as shown above.
The diffuse double layer is more compressed.