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# APPENDICES

## Appendix A : Figures

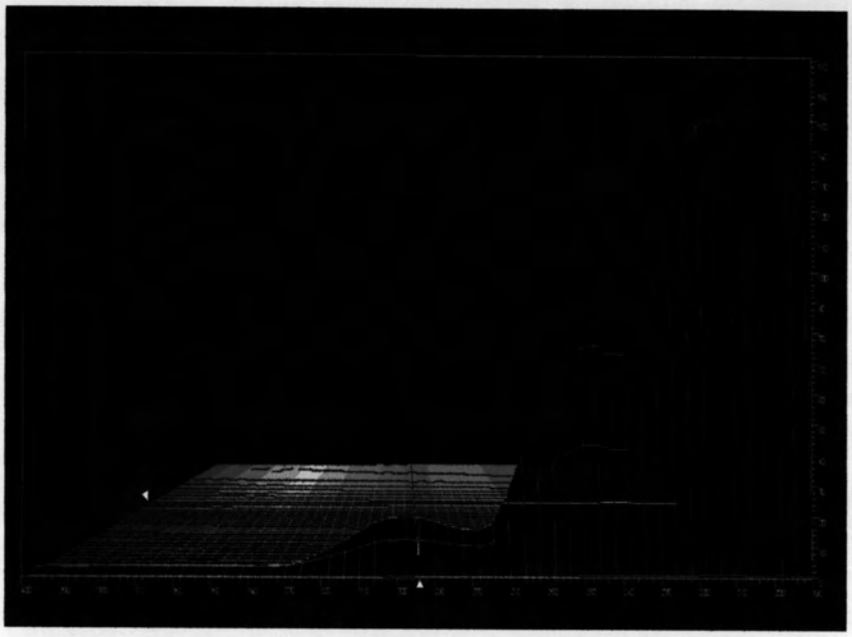

**Figure 1** The example of the UV spectra of polymerizable surfactant before polymerization

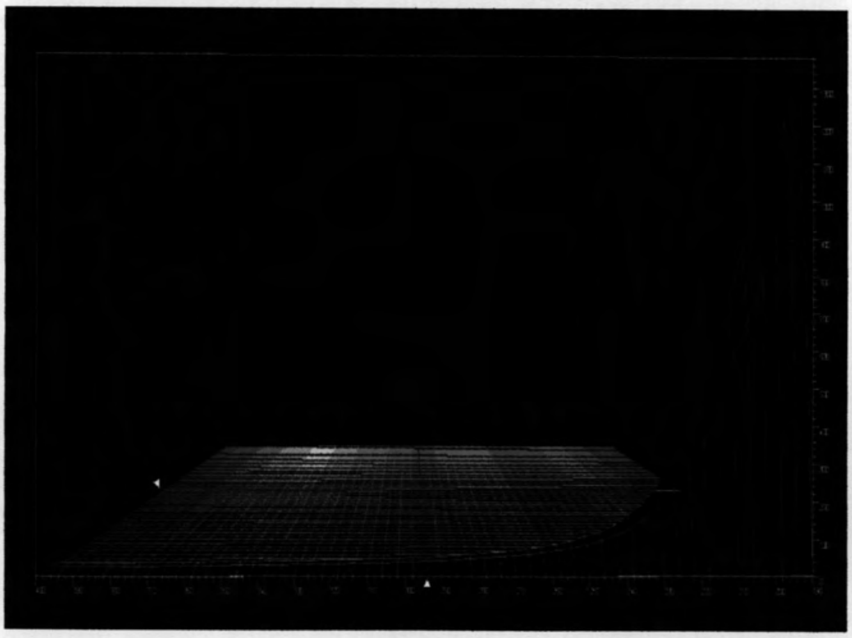

**Figure 2** The example of the UV spectra of polymerizable surfactant after polymerization

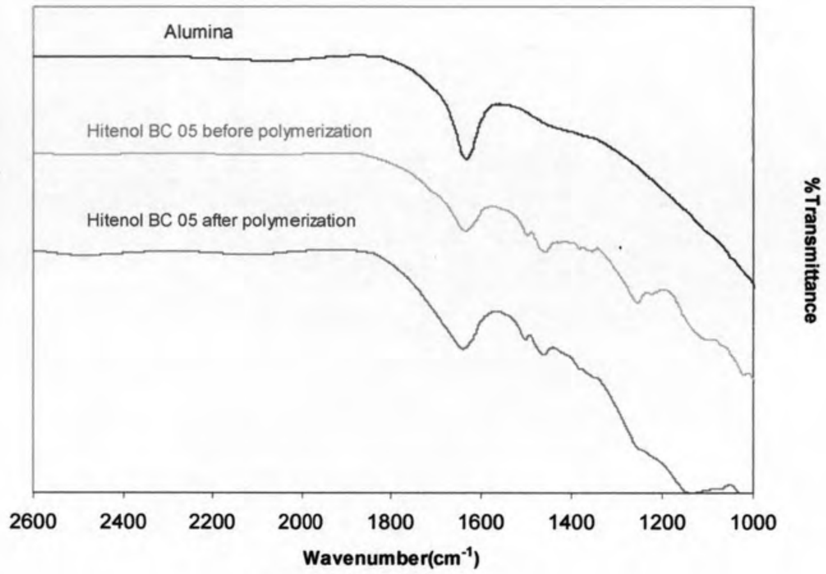


**Figure 3** The FTIR spectra between 1000 and 2600 cm$^{-1}$ of alumina, Hitenol BC 05 before polymerization, and Hitenol BC 05 after polymerization

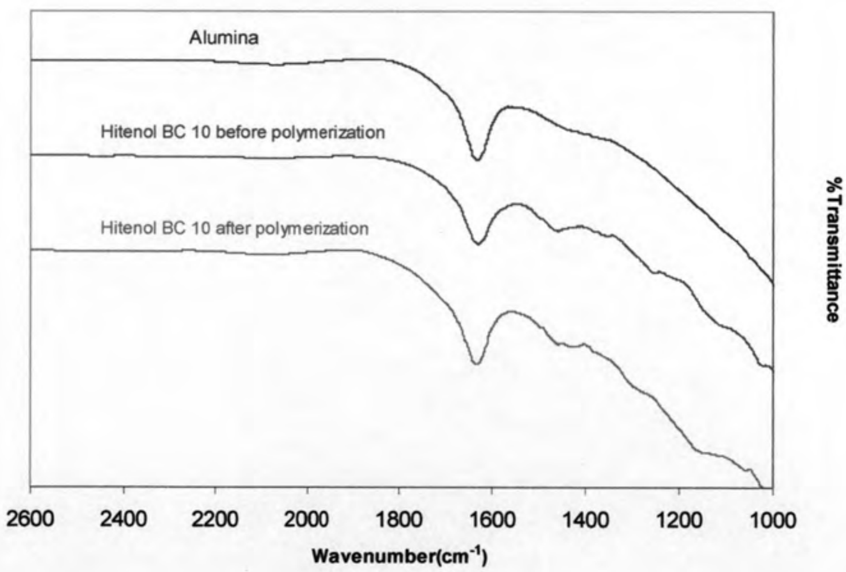


**Figure 4** The FTIR spectra between 1000 and 2600 cm$^{-1}$ of alumina, Hitenol BC 10 before polymerization, and Hitenol BC 10 after polymerization

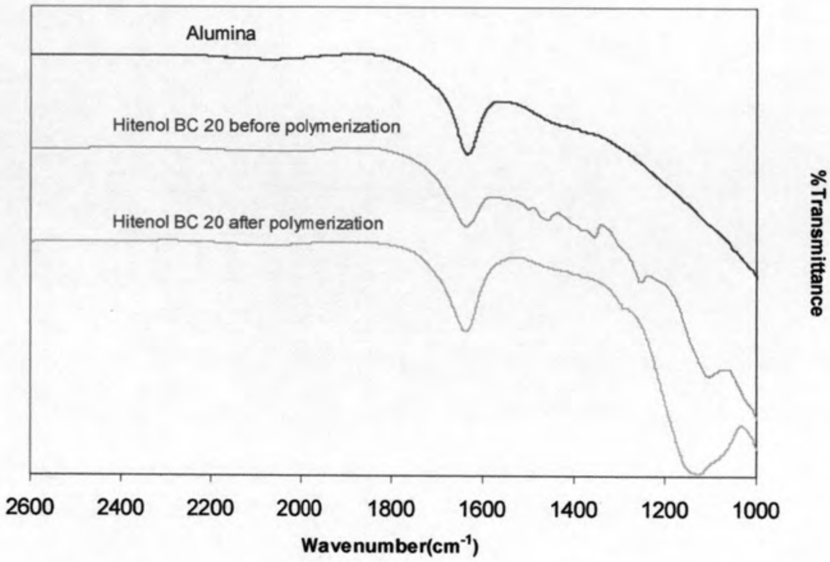


**Figure 5** The FTIR spectra between 1000 and 2600 cm$^{-1}$ of alumina, Hitenol BC 20 before polymerization, and Hitenol BC 20 after polymerization

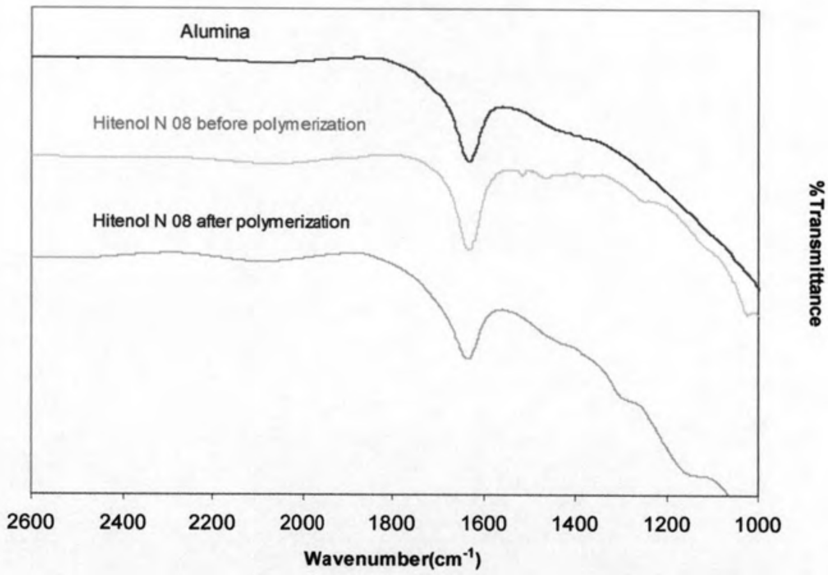


**Figure 6** The FTIR spectra between 1000 and 2600 cm$^{-1}$ of alumina, Hitenol N 08 before polymerization, and Hitenol BC N 08 after polymerization

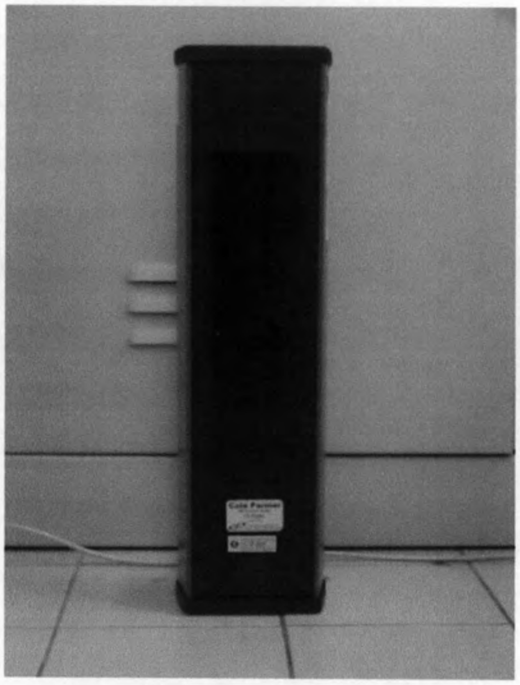

**Figure 7** The UV lamp (9815 series, Cole - Palmer Instrument Company with UV lamp 2×15 watts) for polymerization study

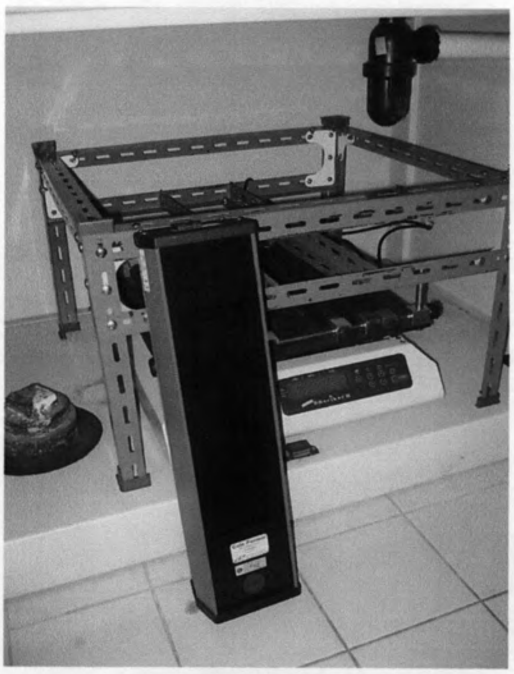

**Figure 8** The polymerization system with the UV lamp (9815 series, Cole - Palmer Instrument Company with UV lamp 2×15 watts) for polymerization study

**Figure 9** The High Performance Liquid Chromatography (HPLC 1100, Agilent) with UV detector without column

**Figure 10** Gas Chromatography (GC 6890N, Agilent) with FID detector


**Figure 11** UV/Visible spectrophotometer (Helios-Alpha, Thermo Electron Corporation)

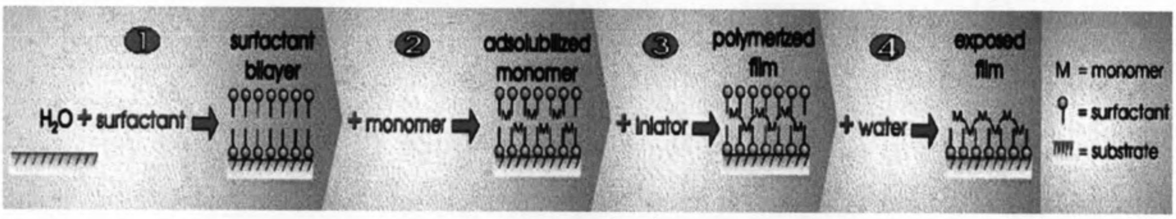


**Figure 12** Schematic presentation of the mechanism of admicellar polymerization (data from http://www.cems.ou.edu/iasr/)

# Appendix B : Equations

## 1.1 Adsorption isotherm

Equation 2.1 was used to calculate the adsorption of the surfactant on the mineral oxide surface.

In this equation, adsorption of water or salt is negligible and the adsorption of surfactant has no effect on the solution density (Lopata, 1988).

$$\Gamma_i = \frac{(C_{i,b} - C_{i,a})V}{W_g} \qquad (2.1)$$

where;

$\Gamma_i$ = Adsorption of surfactant i (mole/g)

$V$ = Volume of sample (liter)

$C_{i,b}$ = Concentration of surfactant at initial (mole/liter)

$C_{i,a}$ = Concentration of surfactant at equilibrium (mole/liter)

$W_g$ = Weight of aluminum oxide (g)

## 1.2 Molecule per area

$$q = \frac{1\text{g}}{\text{Am}^2} \times \frac{(6.023 \times 10^{23}\,\text{molecule})}{\text{mole}} \times \frac{1\text{m}^2}{10^{18}\,\text{nm}^2}$$

A = Surface area of alumina (139.3633g/m$^2$)

### 1.3 The surfactant adsorption ($\Gamma$)

For surface-active solutes the surface excess concentration, $\Gamma$ can be considered to be equal to the actual surface concentration without significant error. Therefore, the concentration of surfactant at the interface may be calculated from surface or interfacial tension data by use of the appropriate Gibbs equation. Gibbs equation applied to aqueous surfactant solution at constant temperature below CMC (Equation 2.2 and 2.3).

For 1:1 ionic surfactant in the presence of a swamping amount of electrolyte containing a common nonsurfactant ion,

$$\Gamma = -\frac{1}{2.303RT}\left(\frac{\partial \gamma}{\partial \log C_1}\right)_T \tag{2.2}$$

For 1:1 ionic surfactant in the absence of any other solutes,

$$\Gamma = -\frac{1}{4.606RT}\left(\frac{\partial \gamma}{\partial \log C_1}\right)_T \tag{2.3}$$

where;

$\gamma$ = Interfacial tension (N/m)
R = 8.314 (J $mol^{-1}$ $K^{-1}$)
T = 298 (K) at 25°C
$C_1$ = Surfactant concentration (Molar)

### 1.4 The area per molecule

The area per molecule at the interface provides information on the degree of packing and the orientation of the adsorbed surfactant molecule when compare with the dimensions of the molecule as obtained by use of molecular models. From the surface excess concentration, the area per molecule at the interface $a^s_1$ in square angstroms is calculated from the equation 2.4,

$$a_1^s = \frac{10^{23}}{NT_1} \tag{2.4}$$

where;

N = Avogado's number ($6.023 \times 10^{23}$)

$\Gamma$ = Surfactant adsorption ($mol/1000m^2$)

## 1.5 Admicellar partition coefficient

The partition of various organic solutes into the admicelles can be described by admicellar partition coefficient as shown in Equation 2.5 (Nayyar et al., 1994),

$$K_{adm} = \frac{X_{adm}}{X_{aq}} \qquad (2.5)$$

where $X_{adm}$ is the molar fraction of organic solute in the admicelle phase

$X_{aq}$ is the molar fraction of organic solute in the aqueous phase

For this study, they are calculated as:

$$X_{adm} = \frac{(C_{i,S} - C_{f,S})}{(C_{i,S} - C_{f,S}) + (S_i - S_f)} \qquad (2.6)$$

$$X_{aq} = \frac{C_{f,s}}{C_{f,s} + 55.55} \qquad (2.7)$$

where;

$X_{adm}$ is the mole fraction of organic solute in admicelle

$C_{i,S}$ is the initial concentration of organic solute (M)

$C_{f,S}$ is the final concentration of organic solute (M)

$S_i$ is the initial concentration of surfactant (M)

$S_f$ is the final concentration of surfactant (M)

55.55 represent 1 molar of water

## 1.6 Hydrophilic/Lipophilic Balance(HLB)

The Hydrophilic/Lipophilic Balance(HLB) Method is the most frequently used method for selecting surfactant for solubilization of organic solutes (Sabatini, 2006)

$$HLB = 7 + \sum(\text{hydrophilic group numbers}) + \sum(\text{hydrophobic group numbers}) \quad (2.8)$$

## Appendix C: Experimental data

**Table C.1** Hitenol BC 05 adsorption onto alumina, initial $10^{-6}$ – $10^{-3}$ M at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5, and temperature of 25±2°C

| Tube | Initial Concentration (M) | Final Concentration (M) | Mass of Alumina (g) | pH equilibrium | q (mole/g) |
|---|---|---|---|---|---|
| 1 | 1.10E-06 | 4.43E-07 | 0.0500 | 6.54 | 5.26E-07 |
| 2 | 4.20E-06 | 9.14E-07 | 0.0501 | 6.52 | 2.63E-06 |
| 3 | 1.77E-05 | 1.77E-06 | 0.0501 | 6.50 | 1.27E-05 |
| 4 | 1.69E-05 | 1.79E-06 | 0.0501 | 6.87 | 1.21E-05 |
| 5 | 9.58E-05 | 2.58E-06 | 0.0501 | 6.86 | 7.46E-05 |
| 6 | 2.07E-04 | 3.63E-06 | 0.0501 | 6.71 | 1.62E-04 |
| 7 | 2.50E-04 | 1.18E-05 | 0.0501 | 6.97 | 1.90E-04 |
| 8 | 3.00E-04 | 2.94E-05 | 0.0500 | 6.91 | 2.16E-04 |
| 9 | 3.10E-04 | 2.43E-05 | 0.0499 | 6.91 | 2.28E-04 |
| 10 | 4.27E-04 | 7.29E-05 | 0.0502 | 6.76 | 2.83E-04 |
| 11 | 5.44E-04 | 1.24E-04 | 0.0500 | 6.73 | 3.36E-04 |
| 12 | 5.93E-04 | 2.03E-04 | 0.0499 | 6.98 | 3.12E-04 |
| 13 | 9.09E-04 | 5.64E-04 | 0.0500 | 7.17 | 2.76E-04 |
| 14 | 1.31E-03 | 9.89E-04 | 0.0499 | 7.13 | 2.57E-04 |
| 15 | 1.64E-03 | 1.26E-03 | 0.0500 | 7.14 | 3.02E-04 |
| | | | | **av. plateau** | 2.97E-04 |
| | | | | **stdev** | 3.08E-05 |

**Table C.2** Hitenol BC 10 adsorption onto alumina, initial $10^{-6}$ – $10^{-3}$ M at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5, and temperature of 25±2°C

| Tube | Initial Concentration (M) | Final Concentration (M) | Mass of Alumina (g) | pH equilibrium | q (mole/g) |
|---|---|---|---|---|---|
| 1 | 1.00E-06 | 7.55E-07 | 0.0499 | 6.89 | 1.50E-08 |
| 2 | 2.00E-06 | 1.07E-06 | 0.0500 | 7.00 | 7.01E-08 |
| 3 | 3.00E-06 | 1.05E-06 | 0.0501 | 6.83 | 3.15E-07 |
| 4 | 6.00E-06 | 1.08E-06 | 0.0502 | 6.95 | 8.52E-07 |
| 5 | 1.00E-05 | 1.45E-06 | 0.0500 | 6.92 | 2.92E-06 |
| 6 | 2.00E-05 | 1.53E-06 | 0.0500 | 6.82 | 9.77E-06 |
| 7 | 3.00E-05 | 2.29E-06 | 0.0500 | 6.98 | 1.37E-05 |
| 8 | 6.00E-05 | 3.43E-06 | 0.0500 | 6.89 | 3.99E-05 |
| 9 | 8.00E-05 | 3.97E-06 | 0.0501 | 7.02 | 4.64E-05 |
| 10 | 8.50E-05 | 1.06E-05 | 0.0500 | 7.33 | 4.43E-05 |
| 11 | 9.00E-05 | 1.96E-05 | 0.0501 | 7.03 | 4.24E-05 |
| 12 | 1.00E-04 | 4.98E-06 | 0.0499 | 6.91 | 7.42E-05 |
| 13 | 1.50E-04 | 2.38E-05 | 0.0500 | 7.04 | 9.95E-05 |
| 14 | 2.00E-04 | 2.70E-05 | 0.0502 | 6.85 | 1.47E-04 |
| 15 | 2.50E-04 | 8.66E-05 | 0.0501 | 6.70 | 1.33E-04 |
| 16 | 3.00E-04 | 1.09E-04 | 0.0500 | 6.55 | 1.60E-04 |
| 17 | 4.50E-04 | 2.67E-04 | 0.0500 | 6.45 | 1.40E-04 |
| 18 | 6.00E-04 | 3.81E-04 | 0.0502 | 6.80 | 1.73E-04 |
| 19 | 6.50E-04 | 5.57E-04 | 0.0499 | 6.70 | 1.46E-04 |
| 20 | 1.00E-03 | 1.05E-03 | 0.0500 | 6.67 | 1.86E-04 |
| 21 | 3.00E-03 | 3.71E-03 | 0.0501 | 6.79 | 1.04E-04 |
| | | | | **av. plateau** | 1.49E-04 |
| | | | | **stdev** | 2.74E-05 |

**Table C.3** Hitenol BC 20 adsorption onto alumina, initial $10^{-6}$ – $10^{-3}$ M at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5, and temperature of 25±2°C

| Tube | Initial Concentration (M) | Final Concentration (M) | Mass of Alumina (g) | pH equilibrium | q (mole/g) |
|---|---|---|---|---|---|
| 1 | 3.67E-07 | 1.31E-07 | 0.0499 | 6.54 | 1.88E-07 |
| 2 | 1.60E-06 | 4.45E-07 | 0.0500 | 6.62 | 9.25E-07 |
| 3 | 5.24E-06 | 8.01E-07 | 0.0499 | 6.72 | 3.53E-06 |
| 4 | 8.66E-06 | 1.92E-06 | 0.0502 | 6.65 | 5.37E-06 |
| 5 | 1.75E-05 | 2.53E-06 | 0.0502 | 6.71 | 1.20E-05 |
| 6 | 2.97E-05 | 4.64E-06 | 0.0502 | 6.74 | 1.99E-05 |
| 7 | 3.47E-05 | -2.18E-06 | 0.0502 | 6.88 | 2.95E-05 |
| 8 | 5.63E-05 | 1.07E-05 | 0.0500 | 6.54 | 3.64E-05 |
| 9 | 7.19E-05 | 1.26E-05 | 0.0502 | 6.65 | 4.74E-05 |
| 10 | 9.27E-05 | 2.22E-05 | 0.0502 | 6.65 | 5.65E-05 |
| 11 | 1.49E-04 | 5.54E-05 | 0.0502 | 6.78 | 7.51E-05 |
| 12 | 1.98E-04 | 1.00E-04 | 0.0499 | 6.84 | 7.86E-05 |
| 13 | 2.55E-04 | 1.53E-04 | 0.0499 | 6.87 | 8.13E-05 |
| 14 | 3.09E-04 | 2.08E-04 | 0.0499 | 6.53 | 8.09E-05 |
| 15 | 3.50E-04 | 2.51E-04 | 0.0501 | 6.64 | 7.92E-05 |
| 16 | 4.51E-04 | 3.48E-04 | 0.0500 | 6.55 | 8.22E-05 |
| 17 | 6.23E-04 | 5.40E-04 | 0.0500 | 6.45 | 6.63E-05 |
| | | | | **av. plateau** | 7.76E-05 |
| | | | | **stdev** | 5.52E-06 |

**Table C.4** Hitenol N 08 adsorption onto alumina, initial $10^{-6}$ – $10^{-3}$ M at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5, and temperature of 25±2°C

| Tube | Initial Concentration (M) | Final Concentration (M) | Mass of Alumina (g) | pH equilibrium | q (mole/g) |
|---|---|---|---|---|---|
| 1 | 3.60E-06 | 3.48E-06 | 0.0499 | 6.89 | 9.52E-08 |
| 2 | 5.00E-06 | 5.14E-06 | 0.0502 | 6.95 | -1.12E-07 |
| 3 | 7.15E-06 | 7.61E-06 | 0.0500 | 6.92 | -3.64E-07 |
| 4 | 2.95E-05 | 1.04E-05 | 0.0500 | 6.82 | 1.53E-05 |
| 5 | 6.19E-05 | 1.28E-05 | 0.0500 | 6.98 | 3.93E-05 |
| 6 | 1.19E-04 | 2.35E-05 | 0.0500 | 6.89 | 7.60E-05 |
| 7 | 1.82E-04 | 4.63E-05 | 0.0501 | 7.02 | 1.09E-04 |
| 8 | 2.38E-04 | 6.50E-05 | 0.0500 | 7.33 | 1.38E-04 |
| 9 | 3.74E-04 | 1.54E-04 | 0.0501 | 7.03 | 1.76E-04 |
| 10 | 4.44E-04 | 1.70E-04 | 0.0499 | 6.91 | 2.19E-04 |
| 11 | 5.15E-04 | 2.09E-04 | 0.0500 | 7.04 | 2.46E-04 |
| 12 | 5.07E-04 | 2.01E-04 | 0.0502 | 6.85 | 2.46E-04 |
| 13 | 6.38E-04 | 2.95E-04 | 0.0501 | 6.70 | 2.75E-04 |
| 14 | 6.31E-04 | 2.87E-04 | 0.0500 | 6.55 | 2.75E-04 |
| 15 | 7.61E-04 | 4.24E-04 | 0.0500 | 6.45 | 2.70E-04 |
| 16 | 7.53E-04 | 4.16E-04 | 0.0502 | 6.80 | 2.70E-04 |
| 17 | 8.26E-04 | 4.85E-04 | 0.0499 | 6.70 | 2.73E-04 |
| 18 | 8.88E-04 | 5.05E-04 | 0.0500 | 6.67 | 3.07E-04 |
| 19 | 1.27E-03 | 8.45E-04 | 0.0501 | 6.79 | 3.38E-04 |
| 20 | 3.65E-03 | 3.24E-03 | 0.0500 | 6.77 | 3.28E-04 |
| | | | | **av. plateau** | 2.83E-04 |
| | | | | **stdev** | 3.15E-05 |

Table C.5 Adsolubilization of styrene by Hitenol BC 05 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 05 (M) | | | Styrene (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | average | final | initial-final | Xaq($10^{-5}$) | | |
| 1 | 3.00E-04 | 3.87E-05 | 2.61E-04 | 2.18E-04 | 3.6 | - | - | 3.6 | 5.99E-05 | 1.58E-04 | 0.11 | 0.38 | 3.50 |
| 2 | 3.00E-04 | 3.87E-05 | 2.61E-04 | 4.36E-04 | 9.5 | 9.3 | 9.4 | 9.4 | 2.43E-04 | 1.94E-04 | 0.44 | 0.43 | 0.97 |
| 3 | 3.00E-04 | 3.87E-05 | 2.61E-04 | 6.55E-04 | 16.8 | 16.5 | 17.1 | 16.8 | 4.76E-04 | 1.79E-04 | 0.86 | 0.41 | 0.47 |
| 4 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 8.73E-04 | 22.6 | 23.2 | 22.0 | 22.6 | 6.59E-04 | 2.14E-04 | 1.19 | 0.45 | 0.38 |
| 5 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 1.09E-03 | 23.2 | - | - | 23.2 | 6.78E-04 | 4.13E-04 | 1.22 | 0.61 | 0.50 |
| 6 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 1.31E-03 | 31.2 | 31.8 | 30.9 | 31.3 | 9.33E-04 | 3.76E-04 | 1.68 | 0.59 | 0.35 |
| 7 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 1.53E-03 | 36.6 | 37.1 | 34.3 | 36.0 | 1.08E-03 | 4.46E-04 | 1.95 | 0.63 | 0.32 |
| 8 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 1.75E-03 | 38.4 | 39.6 | 36.3 | 38.1 | 1.15E-03 | 5.98E-04 | 2.06 | 0.69 | 0.34 |
| 9 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 1.96E-03 | 42.0 | - | - | 42.0 | 1.27E-03 | 6.94E-04 | 2.29 | 0.73 | 0.32 |
| 10 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 2.18E-03 | 44.1 | 43.2 | 41.7 | 43.0 | 1.30E-03 | 8.80E-04 | 2.34 | 0.77 | 0.33 |
| 11 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 2.40E-03 | 35.4 | 38.7 | 35.7 | 36.6 | 1.10E-03 | 1.30E-03 | 1.98 | 0.83 | 0.42 |
| 12 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 2.62E-03 | 48.9 | - | - | 48.9 | 1.49E-03 | 1.13E-03 | 2.68 | 0.81 | 0.30 |

Table C.6 Adsolubilization of styrene by Hitenol BC 10 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C by data from Emma Asnachinda

| Sample | Hitenol N08 (M) | | | Styrene (M) | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | final | initial-final | Xaq($10^{-5}$) | | |
| 1 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 4.36E-04 | 9.83E-05 | 3.38E-04 | 0.18 | 0.79 | 4.49 |
| 2 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 6.55E-04 | 2.35E-04 | 4.19E-04 | 0.42 | 0.83 | 1.95 |
| 3 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 1.31E-03 | 4.52E-04 | 8.57E-04 | 0.81 | 0.91 | 1.12 |
| 4 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 1.53E-03 | 4.90E-04 | 1.04E-03 | 0.88 | 0.92 | 1.05 |
| 5 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 1.96E-03 | 5.77E-04 | 1.39E-03 | 1.04 | 0.94 | 0.91 |
| 6 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.18E-03 | 5.85E-04 | 1.60E-03 | 1.05 | 0.95 | 0.90 |
| 7 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.40E-03 | 1.09E-03 | 1.31E-03 | 1.96 | 0.94 | 0.48 |
| 8 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.62E-03 | 6.86E-04 | 1.93E-03 | 1.24 | 0.96 | 0.77 |
| 9 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.84E-03 | 6.60E-04 | 2.18E-03 | 1.19 | 0.96 | 0.81 |
| 10 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 3.05E-03 | 7.10E-04 | 2.34E-03 | 1.28 | 0.96 | 0.75 |
| 11 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 3.27E-03 | 8.51E-04 | 2.42E-03 | 1.53 | 0.97 | 0.63 |

Table C.7 Adsolubilization of styrene by Hitenol BC 20 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 20 (M) | | | Styrene (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | Average | final | initial-final | Xaq($10^{-5}$) | | |
| 1 | 1.00E-04 | 3.15E-05 | 6.85E-05 | 4.36E-04 | 7.7 | 9.8 | 8.9 | 8.8 | 2.24E-04 | 2.13E-04 | 0.40 | 0.76 | 1.88 |
| 2 | 1.00E-04 | 3.15E-05 | 6.85E-05 | 6.55E-04 | 13.2 | 12.5 | 11.8 | 12.5 | 3.40E-04 | 3.14E-04 | 0.61 | 0.82 | 1.34 |
| 3 | 1.00E-04 | 3.15E-05 | 6.85E-05 | 8.73E-04 | 18.0 | 16.9 | 15.8 | 16.9 | 4.79E-04 | 3.94E-04 | 0.86 | 0.85 | 0.99 |
| 4 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 1.09E-03 | 23.0 | - | - | 23.0 | 6.71E-04 | 4.20E-04 | 1.21 | 0.86 | 0.71 |
| 5 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 1.31E-03 | 26.4 | 24.4 | 26.3 | 25.7 | 7.56E-04 | 5.53E-04 | 1.36 | 0.89 | 0.65 |
| 6 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 1.53E-03 | 30.0 | 28.2 | 29.7 | 29.3 | 8.70E-04 | 6.58E-04 | 1.57 | 0.91 | 0.58 |
| 7 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 1.75E-03 | 32.0 | 34.1 | 33.5 | 33.2 | 9.93E-04 | 7.53E-04 | 1.79 | 0.92 | 0.51 |
| 8 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 1.96E-03 | 36.0 | - | - | 36.0 | 1.08E-03 | 8.83E-04 | 1.95 | 0.93 | 0.48 |
| 9 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 2.18E-03 | 39.6 | 37.0 | 35.0 | 37.2 | 1.12E-03 | 1.06E-03 | 2.01 | 0.95 | 0.47 |
| 10 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 2.40E-03 | 38.2 | 39.0 | 38.0 | 38.4 | 1.16E-03 | 1.24E-03 | 2.08 | 0.95 | 0.46 |
| 11 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 2.62E-03 | 40.1 | - | - | 40.1 | 1.21E-03 | 1.41E-03 | 2.18 | 0.96 | 0.44 |
| 12 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 2.84E-03 | 43.5 | - | - | 43.5 | 1.32E-03 | 1.52E-03 | 2.37 | 0.96 | 0.41 |
| 13 | 1.00E-04 | 4.25E-05 | 5.75E-05 | 3.05E-03 | 45.2 | 46.9 | 41.1 | 44.4 | 1.35E-03 | 1.71E-03 | 2.42 | 0.97 | 0.40 |
| 14 | 1.00E-04 | 4.25E-05 | 5.75E-05 | 3.27E-03 | 48.7 | 50.9 | 50.1 | 49.9 | 1.52E-03 | 1.75E-03 | 2.73 | 0.97 | 0.35 |

Table C.8 Adsolubilization of styrene by Hitenol N 08 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol N08 (M) | | | Styrene (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | Average | final | initial-final | Xaq($10^{-5}$) | | |
| 1 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 2.18E-04 | 12.1 | - | - | 12.1 | 1.86E-04 | 3.25E-05 | 0.33 | 0.27 | 0.81 |
| 2 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 4.36E-04 | 22.7 | 25.9 | 24.9 | 24.5 | 4.32E-04 | 4.38E-06 | 0.78 | 0.05 | 0.06 |
| 3 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 6.55E-04 | 34.5 | 37.8 | 34.5 | 35.6 | 6.52E-04 | 2.10E-06 | 1.17 | 0.02 | 0.02 |
| 4 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 8.73E-04 | 45.3 | 47.8 | 47.6 | 46.9 | 8.77E-04 | 4.15E-06 | 1.58 | 0.05 | 0.03 |
| 5 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 1.09E-03 | 63.8 | - | - | 63.8 | 1.21E-03 | 1.22E-04 | 2.18 | 0.58 | 0.27 |
| 6 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 1.31E-03 | 66.5 | 65.4 | 65.2 | 65.7 | 1.25E-03 | 5.88E-05 | 2.25 | 0.40 | 0.18 |
| 7 | 1.00E-04 | 1.27E-05 | 8.73E-05 | 1.53E-03 | 69.0 | 72.1 | 71.3 | 70.8 | 1.35E-03 | 1.76E-04 | 2.43 | 0.67 | 0.27 |
| 8 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 1.75E-03 | 105.6 | 107.2 | 107.6 | 106.8 | 2.07E-03 | 3.21E-04 | 3.72 | 0.79 | 0.21 |
| 9 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 1.96E-03 | 93.5 | - | - | 93.5 | 1.80E-03 | 1.61E-04 | 3.24 | 0.65 | 0.20 |
| 10 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.18E-03 | 94.6 | 96.3 | 95.3 | 95.4 | 1.84E-03 | 3.42E-04 | 3.31 | 0.80 | 0.24 |
| 11 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.40E-03 | 82.2 | 84.7 | 83.3 | 83.4 | 1.60E-03 | 7.98E-04 | 2.88 | 0.90 | 0.31 |
| 12 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.62E-03 | 119.0 | - | - | 119.0 | 2.31E-03 | 3.09E-04 | 4.16 | 0.78 | 0.19 |
| 13 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 2.84E-03 | 119.0 | - | - | 119.0 | 2.31E-03 | 5.28E-04 | 4.16 | 0.86 | 0.21 |
| 14 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 3.05E-03 | 126.1 | 128.2 | 128.8 | 127.7 | 2.48E-03 | 5.73E-04 | 4.47 | 0.87 | 0.19 |
| 15 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 3.27E-03 | 84.3 | 86.6 | 85.0 | 85.3 | 1.64E-03 | 1.63E-03 | 2.95 | 0.95 | 0.32 |

Table C.9 Adsolubilization of ethylcyclohexane by Hitenol BC 05 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 05 (M) | | | Ethylcyclohexane (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | Average | final | initial-final | Xaq(10-5) | | |
| 1 | 3.00E-04 | 3.87E-05 | 2.61E-04 | 2.63E-04 | 1.7 | 1.9 | 1.8 | 1.8 | 6.63E-05 | 1.97E-04 | 0.12 | 0.43 | 3.60 |
| 2 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 3.51E-04 | 2.1 | 3.0 | 2.7 | 2.6 | 8.31E-05 | 2.68E-04 | 0.15 | 0.50 | 3.35 |
| 3 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 4.39E-04 | 4.7 | 5.3 | 5.3 | 5.1 | 1.36E-04 | 3.03E-04 | 0.24 | 0.53 | 2.18 |
| 4 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 5.27E-04 | 6.9 | 7.8 | 8.1 | 7.6 | 1.88E-04 | 3.39E-04 | 0.34 | 0.56 | 1.65 |
| 5 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 8.78E-04 | 14.3 | 15.3 | 16.0 | 15.2 | 3.47E-04 | 5.30E-04 | 0.63 | 0.67 | 1.08 |
| 6 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 9.66E-04 | 19.2 | 19.9 | 19.4 | 19.5 | 4.37E-04 | 5.28E-04 | 0.79 | 0.67 | 0.85 |

Table C.10 Adsolubilization of ethylcyclohexane by Hitenol BC 10 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 05 (M) | | | Ethylcyclohexane (M) | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | final | initial-final | Xaq(10-5) | | |
| 1 | 3.00E-04 | 3.87E-05 | 2.61E-04 | 2.63E-04 | 2.41E-04 | 2.24E-05 | 0.43 | 0.08 | 0.18 |
| 2 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 3.51E-04 | 2.37E-04 | 1.14E-04 | 0.43 | 0.30 | 0.70 |
| 3 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 4.39E-04 | 2.81E-04 | 1.58E-04 | 0.51 | 0.37 | 0.74 |
| 4 | 3.00E-04 | 3.34E-05 | 2.67E-04 | 5.27E-04 | 3.29E-04 | 1.97E-04 | 0.59 | 0.43 | 0.72 |
| 5 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 6.14E-04 | 3.08E-04 | 3.06E-04 | 0.55 | 0.54 | 0.98 |
| 6 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 7.02E-04 | 3.29E-04 | 3.73E-04 | 0.59 | 0.59 | 1.00 |
| 7 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 7.90E-04 | 3.29E-04 | 4.61E-04 | 0.59 | 0.64 | 1.08 |
| 8 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 8.78E-04 | 3.52E-04 | 5.25E-04 | 0.63 | 0.67 | 1.06 |
| 9 | 3.00E-04 | 4.25E-05 | 2.58E-04 | 9.66E-04 | 3.52E-04 | 6.13E-04 | 0.63 | 0.70 | 1.11 |

**Table C.11** Adsolubilization of ethylcyclohexane by Hitenol BC 20 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 05 (M) | | | Ethylcyclohexane (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | Average | final | initial-final | Xaq(10-5) | | |
| 1 | 1.00E-04 | 3.15E-05 | 6.85E-05 | 3.51E-04 | 14.5 | 15.2 | 14.9 | 14.9 | 3.41E-04 | 1.05E-05 | 0.61 | 0.13 | 0.22 |
| 2 | 1.00E-04 | 3.15E-05 | 6.85E-05 | 4.39E-04 | 17.4 | 17.7 | 17.6 | 17.6 | 3.97E-04 | 4.23E-05 | 0.71 | 0.38 | 0.53 |
| 3 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 5.27E-04 | 18.1 | 17.9 | 19.0 | 18.3 | 4.13E-04 | 1.14E-04 | 0.74 | 0.62 | 0.84 |
| 4 | 1.00E-04 | 3.14E-05 | 6.86E-05 | 6.14E-04 | 20.6 | 19.4 | 20.0 | 20.0 | 4.48E-04 | 1.67E-04 | 0.81 | 0.71 | 0.88 |
| 5 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 7.02E-04 | 20.9 | 21.8 | 22.1 | 21.6 | 4.82E-04 | 2.21E-04 | 0.87 | 0.78 | 0.90 |
| 6 | 1.00E-04 | 3.93E-05 | 6.07E-05 | 7.90E-04 | 20.3 | 19.6 | 19.9 | 19.9 | 4.47E-04 | 3.43E-04 | 0.80 | 0.85 | 1.06 |
| 7 | 1.00E-04 | 4.25E-05 | 5.75E-05 | 8.78E-04 | 22.0 | 21.1 | 21.8 | 21.6 | 4.82E-04 | 3.96E-04 | 0.87 | 0.87 | 1.01 |

**Table C.12** Adsolubilization of ethylcyclohexane by Hitenol N 08 onto alumina at electrolyte concentration of 0.001 M NaCl, equilibrium pH of 7 ± 0.5 and temperature of 25±2°C

| Sample | Hitenol BC 05 (M) | | | Ethylcyclohexane (M) | | | | | | | | Xadm | Kadm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | initial | final | initial-final | initial | response 1 | response 2 | response 3 | Average | final | initial-final | Xaq(10-5) | | |
| 1 | 1.00E-04 | 1.12E-05 | 8.88E-05 | 4.39E-04 | 14.9 | 15.8 | 15.1 | 15.3 | 3.49E-04 | 9.02E-05 | 0.63 | 0.50 | 0.80 |
| 2 | 1.00E-04 | 1.12E-05 | 8.88E-05 | 5.27E-04 | 17.0 | 16.7 | 17.3 | 17.0 | 3.85E-04 | 1.42E-04 | 0.69 | 0.61 | 0.89 |
| 3 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 6.14E-04 | 20.4 | 20.7 | 20.1 | 20.4 | 4.56E-04 | 1.58E-04 | 0.82 | 0.65 | 0.79 |
| 4 | 1.00E-04 | 1.35E-05 | 8.65E-05 | 7.02E-04 | 24.6 | 24.9 | 24.3 | 24.6 | 5.44E-04 | 1.58E-04 | 0.98 | 0.65 | 0.66 |
| 5 | 1.00E-04 | 1.28E-05 | 8.72E-05 | 7.90E-04 | 25.1 | 25.7 | 25.3 | 25.4 | 5.61E-04 | 2.30E-04 | 1.01 | 0.72 | 0.72 |

**Table C.13** Desorption data of Hitenol BC 05 adsorbed onto alumina with polymerization

| Hitneol BC 05 | Concentration | | Peak area at λ =230 | Desorbed Peak Area |
|---|---|---|---|---|
| Below CMC | 1.00E-04 (monolayer) | Initial | 0.000 | 0.008 |
| | | Final | 0.008 | |
| | 3.00E-04 (bilayer) | Initial | 0.004 | 0.020 |
| | | Final | 0.024 | |
| Above CMC | 1.00E-03 (bilayer) | Initial | 0.001 | 0.037 |
| | | Final | 0.038 | |

**Table C.14** Desorption data of Hitenol BC 20 adsorbed onto alumina with polymerization

| Hitenol BC 20 | Concentration | | Peak area at λ =230 | Desorbed Peak Area |
|---|---|---|---|---|
| Below CMC | 1.00E-05 (monolayer) | Initial | 0.000 | 0.000 |
| | | Final | 0.000 | |
| | 1.00E-04 (bilayer) | Initial | 0.000 | 0.004 |
| | | Final | 0.004 | |
| Above CMC | 1.00E-03 (bilayer) | Initial | 0.000 | 0.003 |
| | | Final | 0.003 | |

**Table C.15** Desorption data of Hitenol N 08 adsorbed onto alumina without polymerization

| Hitenol N 08 (W/OPolymerization) | Concentration | | Peak area at λ =230 | Desorbed Peak Area |
|---|---|---|---|---|
| Below CMC | 2.00E-05 (monolayer) | Initial | 0.000 | 0.008 |
| | | Final | 0.008 | |
| | 1.00E-04 (bilayer) | Initial | 0.000 | 0.038 |
| | | Final | 0.038 | |
| Above CMC | 1.00E-03 (bilayer) | Initial | 0.002 | 0.069 |
| | | Final | 0.071 | |

**Table C.16** Desorption data of Hitenol N 08 adsorbed onto alumina with polymerization

| Hitenol N 08 (W polymerization) | Concentration | | Peak area at λ =230 | Desorbed Peak Area |
|---|---|---|---|---|
| Below CMC | 2.00E-05 (monolayer) | Initial | 0.003 | 0.000 |
| | | Final | 0.003 | |
| | 1.00E-04 (bilayer) | Initial | 0.003 | 0.027 |
| | | Final | 0.030 | |
| Above CMC | 1.00E-03 (bilayer) | Initial | 0.003 | 0.059 |
| | | Final | 0.062 | |

**Table C.17** Surface tension of Hitenol BC 05 at electrolyte concentration of 0.001 M NaCl and temperature of 25±2°C by Tensiometer

| Tube | Concentration M | Surface tension mN/m. |
|---|---|---|
| 1 | 1.00E-06 | 64.983 |
| 2 | 3.00E-06 | 55.830 |
| 3 | 1.00E-05 | 47.842 |
| 4 | 3.00E-05 | 42.793 |
| 5 | 5.00E-05 | 37.311 |
| 6 | 1.00E-04 | 34.672 |
| 7 | 1.50E-04 | 32.918 |
| 8 | 2.00E-04 | 32.050 |
| 9 | 3.00E-04 | 32.794 |
| 10 | 1.00E-03 | 33.539 |
| 11 | 3.00E-03 | 33.185 |
| 12 | 1.00E-02 | 32.013 |

**Table C.18** Surface tension of Hitenol BC 10 at electrolyte concentration of 0.001 M NaCl and temperature of 25±2°C by Tensiometer

| Tube | Concentration M | Surface tension mN/m. |
|---|---|---|
| 1 | 1.00E-06 | 63.457 |
| 2 | 3.00E-06 | 57.734 |
| 3 | 1.00E-05 | 53.389 |
| 4 | 2.00E-05 | 46.671 |
| 5 | 3.00E-05 | 46.232 |
| 6 | 6.00E-05 | 42.917 |
| 7 | 8.00E-05 | 40.456 |
| 8 | 1.00E-04 | 41.012 |
| 9 | 1.50E-04 | 40.456 |
| 10 | 2.00E-04 | 40.552 |
| 11 | 3.00E-04 | 40.297 |
| 12 | 1.00E-03 | 39.753 |
| 13 | 3.00E-03 | 40.679 |
| 14 | 1.00E-02 | 39.474 |

Table C.19 Surface tension of Hitenol BC 20 at electrolyte concentration of 0.001 M NaCl and temperature of 25±2°C by Tensiometer

| Tube | Concentration M | Surface tension mN/m. |
|---|---|---|
| 1 | 1.00E-06 | 63.776 |
| 2 | 3.00E-06 | 59.590 |
| 3 | 1.00E-05 | 56.041 |
| 4 | 2.00E-05 | 53.606 |
| 5 | 3.00E-05 | 52.223 |
| 6 | 6.00E-05 | 48.329 |
| 7 | 1.00E-04 | 46.980 |
| 8 | 1.50E-04 | 47.752 |
| 9 | 3.00E-04 | 47.802 |
| 10 | 1.00E-03 | 46.963 |
| 11 | 3.00E-03 | 46.259 |
| 12 | 1.00E-02 | 45.101 |

Table C.20 Surface tension of Hitenol N 08 at electrolyte concentration of 0.001 M NaCl and temperature of 25±2°C by Tensiometer

| Tube | Concentration M | Surface tension mN/m. |
|---|---|---|
| 1 | 1.00E-06 | 62.522 |
| 2 | 3.00E-06 | 54.513 |
| 3 | 1.00E-05 | 52.111 |
| 4 | 3.00E-05 | 43.909 |
| 5 | 6.00E-05 | 39.848 |
| 6 | 1.00E-04 | 34.757 |
| 7 | 1.50E-04 | 31.703 |
| 8 | 2.00E-04 | 30.766 |
| 9 | 3.00E-04 | 30.494 |
| 10 | 5.00E-04 | 30.639 |
| 11 | 1.00E-03 | 32.339 |
| 12 | 3.00E-03 | 34.344 |
| 13 | 1.00E-02 | 34.205 |

# BIOGRAPHY

Miss Chodchanok Attaphong was born in Bangkok, Thailand, on 1 July 1983. In year 2004, she graduated in Bachelor of Engineering, Department of Environmental Engineering, Faculty of Engineering at Chulalongkorn University, Bangkok, Thailand. At the time of this study, she was an M.S. student with a major in Environmental Management at the National Research Center for Environmental and Hazardous Waste Management (NRC-EHWM), Chulalongkorn University, Bangkok, Thailand.