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APPENDICES

Table A-1 The amount of surfactant adsorbed on aluminum oxide at pH 3.5 and at 30 °C

Surfactant	Initial concentration (µM)	Equilibrium concentration (µM)	Adsorbed surfactant (µmole/g of alumina)
Triton X-100	165	152.2	0.64
1:3	19000	13900	255
1:1	12000	6300	285
3:1	9800	1060	437
SDS	13000	1300	585

Note: The ratios of these values belong to the ratio of anionic:nonionic surfactant.

Table A-2 Adsorption Isotherm of Triton X-100 at pH 3.5 and at 30 °C

Initial concentration (µM)	Equilibrium concentration (µM)	Adsorbed surfactant (µmole/g of alumina)
40	34.5962	0.2702
50	43.9661	0.3017
70	63.4265	0.3287
80	72.7963	0.3602
100	90.8151	0.4592
200	185.2341	0.7383
250	233.5247	0.8238
300	281.8153	0.9092
400	382.0002	0.9000
600	583.8117	0.8094

Table A-3 Adsorption Isotherm of SDS at pH 3.5 and at 30 °C

Initial concentration (μM)	**Equilibrium concentration (μM)**	**Adsorbed surfactant (μmole/g of alumina)**
600	47.0656	27.6467
900	50.4761	42.4762
2000	64.8005	96.7600
5000	85.9459	245.7027
8000	151.4284	392.4286
10000	394.9417	480.2529
11000	487.0265	525.6487
12500	1034.0788	573.2961
13500	1600.9122	594.9544
14000	1700.5002	614.9750
15000	2355.3258	632.2337
17500	4926.1984	628.6901
20000	7216.7238	639.1638
22000	8676.4392	666.1780
24000	10293.0399	685.3480
26000	12162.0213	691.8989
26500	12557.6451	697.1177
27000	13601.2734	669.9363
28000	14399.3421	680.0329
28500	14679.0072	691.0496
40000	26227.1295	688.6435

Table A-4 Adsorption Isotherm of Mixed Molar Ratio of SDS:Triton X-100 at 1:3 at pH 3.5 and at 30 °C

Total concentration		Triton X-100 concentration		SDS concentration	
Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)
156.9854	2.1507	130.7480	0.9626	26.2374	1.1881
269.7210	6.5140	228.1410	3.5930	41.5800	2.9210
343.9920	7.8004	291.7910	4.1605	52.2010	3.6400
406.7966	9.6602	354.2750	4.7863	52.5216	4.8739
512.6002	14.3700	459.7820	7.0109	52.8182	7.3591
617.8826	14.1059	537.8410	6.8580	80.0416	7.2479
672.8692	16.3565	603.9210	7.3040	68.9482	9.0526
1265.7342	36.7133	1135.0800	18.2460	130.6542	18.4673
1992.2870	50.3857	1682.4700	28.3765	309.8170	22.0092
2619.0300	69.0485	2252.4800	37.3760	366.5500	31.6725
3312.2260	84.3887	2883.6100	43.3195	428.6160	41.0692
4047.1180	97.6441	3634.4600	43.2770	412.6580	54.3671
4727.2840	113.6358	4144.2500	55.2875	583.0340	58.3483
5469.9940	126.5003	4808.0100	59.5995	661.9840	66.9008
6137.1300	143.1435	5535.4700	60.7265	601.6600	82.4170
6759.9640	162.0018	6302.9800	59.8510	456.9840	102.1508
14590.9940	270.4503	11524.3500	173.7825	3066.6440	96.6678
24157.6200	292.1190	19178.6000	166.0700	4979.0200	126.0490
34373.1400	281.3430	26811.1500	159.4425	7561.9900	121.9005

Table A-5 Adsorption Isotherm of Mixed Molar Ratio of SDS:Triton X-100 at 1:1 at pH 3.5 and at 30 °C

Total concentration		Triton X-100 concentration		SDS concentration	
Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)
120.6664	3.9667	66.4080	1.6796	54.2584	2.2871
168.4997	6.5750	102.3250	2.3838	66.1747	4.1913
219.4225	9.0289	131.4830	3.4259	87.9395	5.6030
256.6380	12.1681	152.5590	4.8721	104.0790	7.2961
300.5651	14.9717	180.0290	5.9986	120.5361	8.9732
339.9823	18.0009	201.6030	7.4199	138.3793	10.5810
367.1837	21.6408	218.1970	9.0902	148.9867	12.5507
386.0046	25.6998	229.1240	11.0438	156.8806	14.6560
415.4787	29.2261	250.3940	12.4803	165.0847	16.7458
736.4981	63.1751	465.0870	26.7457	271.4111	36.4294
1035.5008	98.2250	688.3550	40.5823	347.1458	57.6427
1636.7020	118.1649	1202.8940	39.8553	433.8080	78.3096
1863.9724	156.8014	1233.8700	63.3065	630.1024	93.4949
2357.5753	182.1212	1458.9600	77.0520	898.6153	105.0692
2935.6944	203.2153	1763.5800	86.8210	1172.1144	116.3943
3517.3646	224.1318	2135.9000	93.2050	1381.4646	130.9268
4058.9073	247.0546	2467.9900	101.6005	1590.9173	145.4541
4744.2696	262.7865	2990.8000	100.4600	1753.4696	162.3265
8597.2131	320.1393	5418.7800	104.0610	3178.4331	246.0783
13334.3805	333.2810	8378.6500	101.0675	4955.7305	242.2135

Table A-6 Adsorption Isotherm of Mixed Molar Ratio of SDS:Triton X-100 at 3:1 at pH 3.5 and at 30 °C

Total concentration		Triton X-100 concentration		SDS concentration	
Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)	Equilibrium Concentration (μM)	Adsorbed surfactant (μmole/g alumina)
64.9552	6.7522	21.7820	1.4109	43.1732	5.3413
86.8754	10.6562	34.9740	2.0013	51.9014	8.6549
117.2952	19.1352	47.3150	3.8843	69.9802	15.2510
132.0130	23.3994	48.7800	5.0610	83.2330	18.3384
155.7673	32.2116	59.4960	7.0252	96.2713	25.1864
189.2291	40.5385	67.2450	9.1378	121.9841	31.4008
267.4706	86.6265	96.4870	20.1757	170.9836	66.4508
326.9234	133.6538	117.2020	31.6399	209.7214	102.0139
361.3246	181.9338	146.8530	42.6574	214.4716	139.2764
401.8545	229.9073	139.7760	55.5112	262.0785	174.3961
449.1394	277.5430	148.8880	75.0000	300.2514	209.9874
513.5578	324.3221	196.3380	87.5000	317.2198	246.6390
561.4243	371.9288	181.3410	100.0000	380.0833	280.9958
691.1558	415.4422	214.5140	112.5000	476.6418	313.6679
1183.2408	440.8380	337.9300	125.0000	845.3108	332.7345
5113.2105	494.3395	564.9460	187.5000	4548.2645	335.0868
9895.3820	505.2309	533.8300	250.0000	9361.5520	381.9224
19822.0785	508.8961	536.6610	475.0000	19285.4175	380.7291
30084.2875	495.7856	539.0030	500.0000	29545.2845	382.7358

Table A-7 Adsolubilization of Benzene in Triton X-100 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of benzene = 78 g/mol

Equation from GC Y = 1.0856856X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of benzene = 0.873 g/ml

Adsorption = 0.64 μmol/g alumina

[Benz] initial (μL)	[Benz] initial (μmol/L)	Area at equilibrium	[Benz] eq. (μmol/L)	[Benz] ads. (μmol/L)	[Benz] ads. (μmol/g alumina)	X admicelle	Mole of Benz	Mole of H_2O	X bulk	K
10	9.31E+02	1.07E+03	9.22E+02	9.38E+00	4.69E-01	4.23E-01	1.11E-04	6.67E+00	1.66E-05	2.55E+04
50	4.66E+03	5.28E+03	4.22E+03	4.33E+02	2.16E+01	9.71E-01	5.07E-04	6.66E+00	7.61E-05	1.28E+04
100	9.31E+03	9.51E+03	8.76E+03	5.52E+02	2.76E+01	9.77E-01	1.05E-03	6.66E+00	1.58E-04	6.19E+03
150	1.40E+04	1.37E+04	1.26E+04	1.35E+03	6.74E+01	9.90E-01	1.51E-03	6.66E+00	2.27E-04	4.36E+03
200	1.86E+04	1.87E+04	1.73E+04	1.38E+03	6.89E+01	9.91E-01	2.07E-03	6.66E+00	3.11E-04	3.19E+03

Table A-8 Adsolubilization of Benzene in SDS at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of benzene = 78 g/mol

Equation from GC Y = 1.0856856X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of benzene = 0.873 g/ml

Adsorption = 585 μmol/g alumina

[Benz] initial (μL)	[Benz] initial (μmol/L)	Area at equilibrium	[Benz] eq. (μmol/L)	[Benz] ads. (μmol/L)	[Benz] ads. (μmol/g alumina)	X admicelle	Mole of Benz	Mole of H_2O	X bulk	K
50	4.66E+03	4.23E+03	4.23E+03	4.29E+02	2.15E+01	3.53E-02	5.07E-04	6.66E+00	7.61E-05	4.67E+02
100	9.31E+03	9.51E+03	8.52E+03	7.92E+02	3.96E+01	6.34E-02	1.02E-03	6.66E+00	1.53E-04	4.13E+02
150	1.40E+04	1.19E+04	1.15E+04	2.50E+03	1.25E+02	1.76E-01	1.38E-03	6.66E+00	2.07E-04	8.53E+02
200	1.86E+04	1.85E+04	1.66E+04	2.01E+03	1.00E+02	1.46E-01	1.99E-03	6.66E+00	3.00E-04	4.89E+02
300	2.79E+04	2.29E+04	2.05E+04	7.44E+03	3.72E+02	3.89E-01	2.46E-03	6.65E+00	3.70E-04	1.05E+03

Table A-9 Adsolubilization of Benzene in Mixed Molar Ratio of SDS:Triton X-100 at 1:3 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of benzene = 78 g/mol

Equation from GC Y = 1.0856856X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of benzene = 0.873 g/ml

Adsorption = 255 μmol/g alumina

[Benz] initial (μL)	[Benz] initial (μmol/L)	Area at equilibrium	[Benz] eq. (μmol/L)	[Benz] ads. (μmol/L)	[Benz] ads. (μmol/g alumina)	X admicelle	Mole of Benz	Mole of H_2O	X bulk	K
100	9.31E+03	8.62E+03	7.94E+03	1.38E+03	6.89E+01	2.11E-01	9.52E-04	6.66E+00	1.43E-04	1.49E+03
150	1.40E+04	1.32E+04	1.22E+04	1.81E+03	9.06E+01	1.78E-01	1.54E-03	6.66E+00	2.32E-04	7.68E+02
200	1.86E+04	1.77E+04	1.61E+04	2.48E+03	1.24E+02	3.40E-01	1.92E-03	6.66E+00	2.88E-04	1.19E+03
250	2.33E+04	2.17E+04	1.87E+04	4.62E+03	2.31E+02	4.75E-01	2.24E-03	6.66E+00	3.36E-04	1.41E+03
270	2.51E+04	2.25E+04	1.95E+04	5.62E+03	2.81E+02	5.24E-01	2.34E-03	6.66E+00	3.52E-04	1.49E+03

Table A-10 Adsolubilization of Benzene in Mixed Molar Ratio of SDS:Triton X-100 at 1:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of benzene = 78 g/mol

Equation from GC Y = 1.0856856X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of benzene = 0.873 g/ml

Adsorption = 285 μmol/g alumina

[Benz] initial (μL)	[Benz] initial (μmol/L)	Area at equilibrium	[Benz] eq. (μmol/L)	[Benz] ads. (μmol/L)	[Benz] ads. (μmol/g alumina)	X admicelle	Mole of Benz	Mole of H_2O	X bulk	K
100	9.31E+03	8.61E+03	7.77E+03	1.54E+03	7.72E+01	2.13E-01	9.32E-04	6.66E+00	1.40E-04	1.52E+03
150	1.40E+04	1.26E+04	1.16E+04	2.39E+03	1.20E+02	3.22E-01	1.35E-03	6.66E+00	2.03E-04	1.59E+03
200	1.86E+04	1.56E+04	1.40E+04	4.59E+03	2.30E+02	4.44E-01	1.68E-03	6.66E+00	2.53E-04	1.77E+03
250	2.33E+04	1.70E+04	1.56E+04	7.67E+03	3.83E+02	5.72E-01	1.87E-03	6.66E+00	2.81E-04	2.04E+03
280	2.61E+04	1.88E+04	1.92E+04	6.89E+03	3.45E+02	5.46E-01	2.30E-03	6.66E+00	3.46E-04	1.58E+03

Table A-11 Adsolubilization of Benzene in Mixed Molar Ratio of SDS:Triton X-100 at 3:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of benzene = 78 g/mol

Equation from GC Y = 1.0856856X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of benzene = 0.873 g/ml

Adsorption = 437 μmol/g alumina

[Benz] initial (μL)	[Benz] initial (μmol/L)	Area at equilibrium	[Benz] eq. (μmol/L)	[Benz] ads. (μmol/L)	[Benz] ads. (μmol/g alumina)	X admicelle	Mole of Benz	Mole of H_2O	X bulk	K
100	9.31E+03	7.91E+03	7.29E+03	2.03E+03	1.01E+02	2.14E-01	8.33E-04	6.66E+00	1.25E-04	1.71E+03
150	1.40E+04	1.08E+04	9.93E+03	4.05E+03	2.02E+02	3.13E-01	1.19E-03	6.66E+00	1.79E-04	1.79E+03
200	1.86E+04	1.39E+04	1.28E+04	5.83E+03	2.91E+02	4.11E-01	1.50E-03	6.66E+00	2.26E-04	1.83E+03
250	2.33E+04	1.82E+04	1.67E+04	6.54E+03	3.27E+02	4.27E-01	2.01E-03	6.66E+00	3.02E-04	1.42E+03
300	2.79E+04	2.12E+04	1.95E+04	8.40E+03	4.20E+02	5.35E-01	2.14E-03	6.66E+00	3.22E-04	1.66E+03

Table A-12 Adsolubilization of Toluene in Triton X-100 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of toluene = 92 g/mol

Equation from GC Y = 1.34844041X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of toluene = 0.867 g/ml

Adsorption = 0.64 μmol/g alumina

[Tol] initial (μL)	[Tol] initial (μmol/L)	Area at equilibrium	[Tol] eq. (μmol/L)	[Tol] ads. (μmol/L)	[Tol] ads. (μmol/g alumina)	X admicelle	Mole of Tol	Mole of H_2O	X bulk	K
10	7.84E+02	1.07E+03	7.42E+02	4.25E+01	2.12E+00	7.68E-01	8.90E-05	9.46E-03	1.34E-05	5.76E+04
20	1.57E+03	1.83E+03	1.36E+03	2.13E+02	1.07E+01	9.30E-01	1.63E-04	1.73E-02	2.44E-05	3.85E+04
30	2.35E+03	2.63E+03	2.08E+03	2.69E+02	1.35E+01	9.55E-01	2.50E-04	2.66E-02	3.75E-05	2.55E+04
40	3.14E+03	3.79E+03	2.79E+03	3.51E+02	1.76E+01	9.56E-01	3.34E-04	3.55E-02	5.01E-05	1.91E+04
50	3.92E+03	5.10E+03	3.78E+03	1.36E+02	6.80E+00	9.05E-01	4.54E-04	4.83E-02	6.81E-05	1.33E+04

Table A-13 Adsolubilization of Toluene in SDS at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of toluene = 92 g/mol

Equation from GC Y = 1.34844041X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of toluene = 0.867 g/ml

Adsorption = 585 μmol/g alumina

[Tol] initial (μL)	[Tol] initial (μmol/L)	Area at equilibrium	[Tol] eq. (μmol/L)	[Tol] ads. (μmol/L)	[Tol] ads. (μmol/g alumina)	X admicelle	Mole of Tol	Mole of H_2O	X bulk	K
65	5.10E+03	4.58E+03	3.40E+03	1.70E+03	8.50E+01	1.27E-01	4.08E-04	6.66E+00	6.12E-05	2.08E+03
75	5.88E+03	4.78E+03	3.55E+03	2.33E+03	1.17E+02	1.66E-01	4.26E-04	6.66E+00	6.39E-05	2.63E+03
85	6.67E+03	5.02E+03	3.72E+03	2.95E+03	1.47E+02	2.03E-01	4.42E-04	6.66E+00	6.63E-05	3.06E+03
90	7.06E+03	4.98E+03	3.69E+03	3.37E+03	1.68E+02	2.23E-01	4.43E-04	6.66E+00	6.65E-05	3.37E+03
120	9.41E+03	5.33E+03	3.95E+03	5.46E+03	2.73E+02	3.18E-01	4.74E-04	6.66E+00	7.12E-05	4.48E+03

Table A-14 Adsolubilization of Toluene in Mixed Molar Ratio of SDS:Triton X-100 at 1:3 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of toluene = 92 g/mol

Equation from GC Y = 1.34844041X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of toluene = 0.867 g/ml

Adsorption = 255 μmol/g alumina

[Tol] initial (μL)	[Tol] initial (μmol/L)	Area at equilibrium	[Tol] eq. (μmol/L)	[Tol] ads. (μmol/L)	[Tol] ads. (μmol/g alumina)	X admicelle	Mole of Tol	Mole of H_2O	X bulk	K
60	4.70E+03	4.72E+03	3.50E+03	1.20E+03	6.02E+01	1.79E-01	4.31E-04	6.66E+00	6.47E-05	2.77E+03
65	5.10E+03	5.42E+03	3.87E+03	1.23E+03	6.15E+01	1.94E-01	4.64E-04	6.66E+00	6.96E-05	2.79E+03
75	5.88E+03	6.18E+03	4.58E+03	1.30E+03	6.49E+01	2.13E-01	5.40E-04	6.66E+00	8.10E-05	2.64E+03
80	6.27E+03	6.65E+03	4.93E+03	1.34E+03	6.72E+01	2.25E-01	5.75E-04	6.66E+00	8.63E-05	2.61E+03
85	6.67E+03	6.96E+03	5.16E+03	1.50E+03	7.51E+01	2.52E-01	5.92E-04	6.66E+00	8.89E-05	2.70E+03

Table A-15 Adsolubilization of Toluene in Mixed Molar Ratio of SDS:Triton X-100 at 1:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of toluene = 92 g/mol

Equation from GC Y = 1.34844041X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of toluene = 0.867 g/ml

Adsorption = 285 μmol/g alumina

[Tol] initial (μL)	[Tol] initial (μmol/L)	Area at equilibrium	[Tol] eq. (μmol/L)	[Tol] ads. (μmol/L)	[Tol] ads. (μmol/g alumina)	X admicelle	Mole of Tol	Mole of H_2O	X bulk	K
20	1.57E+03	1.39E+03	1.03E+03	5.37E+02	2.68E+01	8.60E-02	1.24E-04	6.67E+00	1.86E-05	4.64E+03
40	3.14E+03	2.50E+03	1.86E+03	1.28E+03	6.39E+01	1.83E-01	2.23E-04	6.67E+00	3.34E-05	5.50E+03
60	4.70E+03	3.91E+03	2.90E+03	1.81E+03	9.03E+01	2.29E-01	3.62E-04	6.66E+00	5.42E-05	4.23E+03
80	6.27E+03	5.50E+03	4.08E+03	2.19E+03	1.10E+02	2.78E-01	4.90E-04	6.66E+00	7.35E-05	3.78E+03
100	7.84E+03	6.29E+03	4.67E+03	3.18E+03	1.59E+02	3.49E-01	5.74E-04	6.66E+00	8.61E-05	4.07E+03

Table A-16 Adsolubilization of Toluene in Mixed Molar Ratio of SDS:Triton X-100 at 3:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of toluene = 92 g/mol

Equation from GC Y = 1.34844041X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of toluene = 0.867 g/ml

Adsorption = 437 μmol/g alumina

[Tol] initial (μL)	[Tol] initial (μmol/L)	Area at equilibrium	[Tol] eq. (μmol/L)	[Tol] ads. (μmol/L)	[Tol] ads. (μmol/g alumina)	X admicelle	Mole of Tol	Mole of H_2O	X bulk	K
55	4.31E+03	2.81E+03	2.09E+03	2.23E+03	1.11E+02	2.03E-01	2.50E-04	6.67E+00	3.76E-05	5.44E+03
65	5.10E+03	3.29E+03	2.44E+03	2.65E+03	1.33E+02	2.33E-01	2.93E-04	6.66E+00	4.40E-05	5.31E+03
75	5.88E+03	3.73E+03	2.76E+03	3.12E+03	1.56E+02	2.63E-01	3.32E-04	6.66E+00	4.97E-05	5.29E+03
85	6.67E+03	3.93E+03	2.91E+03	3.75E+03	1.88E+02	2.93E-01	3.65E-04	6.66E+00	5.47E-05	5.35E+03
125	9.80E+03	5.96E+03	4.42E+03	5.38E+03	2.69E+02	3.90E-01	5.05E-04	6.66E+00	7.58E-05	5.15E+03

Table A-17 Adsolubilization of Ethylbenzene in Triton X-100 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of ethylbenzene = 106 g/mol

Equation from GC Y = 1.6380934X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of ethylbenzene = 0.867 g/ml

Adsorption = 0.64 μmol/g alumina

[Etb] initial (μL)	[Etb] initial (μmol/L)	Area at equilibrium	[Etb] eq. (μmol/L)	[Etb] ads. (μmol/L)	[Etb] ads. (μmol/g alumina)	X admicelle	Mole of Etb	Mole of H_2O	X bulk	K
10	6.81E+02	9.77E+02	5.96E+02	8.41E+01	4.20E+00	8.78E-01	7.02E-05	6.67E+00	1.05E-05	8.35E+04
15	1.02E+03	1.19E+03	7.26E+02	2.95E+02	1.48E+01	9.56E-01	8.71E-05	6.67E+00	1.31E-05	7.39E+04
20	1.36E+03	1.68E+03	1.02E+03	3.38E+02	1.69E+01	9.63E-01	1.23E-04	6.67E+00	1.84E-05	5.24E+04
25	1.70E+03	1.90E+03	1.16E+03	5.44E+02	2.72E+01	9.77E-01	1.39E-04	6.67E+00	2.08E-05	4.70E+04
30	2.04E+03	2.28E+03	1.39E+03	6.49E+02	3.25E+01	9.81E-01	1.67E-04	6.67E+00	2.51E-05	3.91E+04

Table A-18 Adsolubilization of Ethylbenzene in SDS at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of ethylbenzene = 106 g/mol

Equation from GC Y = 1.6380934X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of ethylbenzene = 0.867 g/ml

Adsorption = 585 μmol/g alumina

[Etb] initial (μL)	[Etb] initial (μmol/L)	Area at equilibrium	[Etb] eq. (μmol/L)	[Etb] ads. (μmol/L)	[Etb] ads. (μmol/g alumina)	X admicelle	Mole of Etb	Mole of H_2O	X bulk	K
20	1.36E+03	4.88E+02	2.98E+02	1.06E+03	5.32E+01	8.33E-02	3.58E-05	6.67E+00	5.36E-06	1.55E+04
30	2.04E+03	8.97E+02	5.47E+02	1.49E+03	7.47E+01	1.13E-01	6.57E-05	6.67E+00	9.85E-06	1.15E+04
45	3.06E+03	1.57E+03	9.57E+02	2.11E+03	1.05E+02	1.53E-01	1.15E-04	6.67E+00	1.72E-05	8.90E+03
65	4.42E+03	2.03E+03	1.24E+03	3.18E+03	1.59E+02	2.14E-01	1.49E-04	6.67E+00	2.23E-05	9.60E+03
75	5.10E+03	2.30E+03	1.41E+03	3.70E+03	1.85E+02	2.40E-01	1.69E-04	6.67E+00	2.53E-05	9.50E+03

Table A-19 Adsolubilization of Ethylbenzene in Mixed Molar Ratio of SDS:Triton X-100 at 1:3 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of ethylbenzene = 106 g/mol

Equation from GC Y = 1.6380934X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of ethylbenzene = 0.867 g/ml

Adsorption = 255 μmol/g alumina

[Etb] initial (μL)	[Etb] initial (μmol/L)	Area at equilibrium	[Etb] eq. (μmol/L)	[Etb] ads. (μmol/L)	[Etb] ads. (μmol/g alumina)	X admicelle	Mole of Etb	Mole of H_2O	X bulk	K
20	1.36E+03	4.91E+02	3.00E+02	1.06E+03	5.31E+01	1.72E-01	3.60E-05	6.67E+00	5.39E-06	3.20E+04
30	2.04E+03	6.90E+02	4.21E+02	1.62E+03	8.10E+01	2.41E-01	5.06E-05	6.67E+00	7.58E-06	3.18E+04
40	2.72E+03	9.38E+02	5.73E+02	2.15E+03	1.07E+02	2.96E-01	6.87E-05	6.67E+00	1.03E-05	2.88E+04
50	3.40E+03	1.13E+03	6.87E+02	2.72E+03	1.36E+02	3.47E-01	8.25E-05	6.67E+00	1.24E-05	2.81E+04
60	4.08E+03	1.52E+03	9.29E+02	3.15E+03	1.58E+02	3.82E-01	1.12E-04	6.67E+00	1.67E-05	2.28E+04

Table A-20 Adsolubilization of Ethylbenzene in Mixed Molar Ratio of SDS:Triton X-100 at 1:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of ethylbenzene = 106 g/mol

Equation from GC Y = 1.6380934X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of ethylbenzene = 0.867 g/ml

Adsorption = 285 μmol/g alumina

[Etb] initial (μL)	[Etb] initial (μmol/L)	Area at equilibrium	[Etb] eq. (μmol/L)	[Etb] ads. (μmol/L)	[Etb] ads. (μmol/g alumina)	X admicelle	Mole of Etb	Mole of H_2O	X bulk	K
10	6.81E+02	4.76E+02	2.91E+02	3.90E+02	1.95E+01	6.40E-02	3.49E-05	6.67E+00	5.23E-06	1.22E+04
20	1.36E+03	1.01E+03	6.15E+02	7.46E+02	3.73E+01	1.16E-01	7.38E-05	6.67E+00	1.11E-05	1.06E+04
30	2.04E+03	1.43E+03	8.75E+02	1.17E+03	5.83E+01	1.70E-01	1.05E-04	6.67E+00	1.57E-05	1.08E+04
40	2.72E+03	1.95E+03	1.19E+03	1.53E+03	7.67E+01	2.18E-01	1.36E-04	6.67E+00	2.04E-05	1.07E+04
50	3.40E+03	2.08E+03	1.27E+03	2.13E+03	1.07E+02	2.69E-01	1.56E-04	6.67E+00	2.35E-05	1.15E+04

Table A-21 Adsolubilization of Ethylbenzene in Mixed Molar Ratio of SDS:Triton X-100 at 3:1 at pH 3.5 and at 30 °C

Weight of aluminum oxide = 2.4 g

Molecular weight of ethylbenzene = 106 g/mol

Equation from GC Y = 1.6380934X

Where Y = area of benzene from head space gas chromatography

X = Equilibrium concentration of benzene (μmol/l)

Density of ethylbenzene = 0.867 g/ml

Adsorption = 437 μmol/g alumina

[Etb] initial (μL)	[Etb] initial (μmol/L)	Area at equilibrium	[Etb] eq. (μmol/L)	[Etb] ads. (μmol/L)	[Etb] ads. (μmol/g alumina)	X admicelle	Mole of Etb	Mole of H_2O	X bulk	K
20	1.36E+03	5.62E+02	3.43E+02	1.02E+03	5.09E+01	1.04E-01	4.12E-05	6.67E+00	6.17E-06	1.71E+04
30	2.04E+03	8.34E+02	5.09E+02	1.53E+03	7.66E+01	1.49E-01	6.11E-05	6.67E+00	9.16E-06	1.63E+04
40	2.72E+03	1.08E+03	6.57E+02	2.07E+03	1.03E+02	1.91E-01	7.88E-05	6.67E+00	1.18E-05	1.63E+04
50	3.40E+03	1.31E+03	7.97E+02	2.61E+03	1.30E+02	2.30E-01	9.56E-05	6.67E+00	1.43E-05	1.61E+04
60	4.08E+03	1.47E+03	8.95E+02	3.19E+03	1.59E+02	2.67E-01	1.07E-04	6.67E+00	1.61E-05	1.68E+04

Sample Calculation A

Surfactant Adsorption Isotherms

Surfactant adsorption isotherm was constructed by plotting the amount of surfactant adsorbed per gram aluma (aluminum oxide) versus equilibrium concentration of surfactant. For example:

Adsorption of SDS

1. To convert the amount of carbon from TOC (ppm) to equilibrium concentration of SDS (μM)

Equation from TOC: $Y = 6.8211X$

where X = the amount of carbon from TOC (ppm)

Y = equilibrium concentration of SDS (μM)

For example: X = 57.9 ppm

So, $Y = 6.8211 \times 57.9$

$= 394.94169$ μM

2. To determine SDS adsorbed concentration (μM)

[Adsorbed SDS] = [Initial SDS] - [Equilibrium SDS]

From [Initial SDS] = 10000 μM

[Equilibrium SDS] = 394.94169 μM

So, [Adsorbed SDS] = 10000 - 394.94169 μM

= 9605.05831 μM

3. To convert adsorption concentration to moles of adsorption

$$\text{Mole} = \frac{\text{Concentration} \times \text{Volume}}{1000}$$

$$\text{Adsorbed SDS } (\mu\text{mole}) = \frac{(\text{Adsorbed SDS } (\mu\text{M})) \times \text{Volume of solution}}{1000}$$

$$\text{Adsorbed SDS } (\mu\text{mole}) = \frac{9605.05831 \times 20}{1000} = 192.1012$$

4. To determine SDS adsorbed per gram alumina

$$\text{Adsorbed SDS } (\mu\text{mole/g alumina}) = \frac{\text{Adsorbed } (\mu\text{mole})}{\text{Amount of alumina (g)}}$$

$$\text{Adsorbed SDS } (\mu\text{mole/g alumina}) = \frac{192.1012}{0.4} = 480.2529$$

Sample Calculation B

Partition Coefficient

$$K = \frac{X_{admicelle}}{X_{bulk}}$$

where $X_{admicelle}$ = mole fraction of solute in the surfactant coverage

X_{bulk} = mole fracion of solute in the bulk

Adsolubilization of benzene in SDS system

Weight of alumina	=	2.4	gram
Volume of solution	=	120	mL

Equation from GC-Head space: $Y = 1.0856856X$

where Y = area of benzene from head space gas chromatography

X = equilibrium concentration of benzene (μM)

Density of benzene	=	0.873	g/mL
Adsorption of SDS	=	585	μmole/g alumina

Initial concentration of benzene (g/L) convert to (mole/L)

$$[\text{Benzene, mol/l}] = \frac{[\text{Benzene, g/l}]}{\text{Molecular weight}}$$

$$[\text{Benzene, } \mu\text{mol/l}] = \frac{0.36375}{78} \times 10^6 = 4656.8941$$

At equilibrium benzene concentration from area of GC

From $Y = 1.0856856X$

Y = Area = 4233.367 Replace in the equation

$$X = \frac{4590.1}{1.0856856} = 4227.8354\ \mu M$$

Benzene adsolubilization = [Benzene] initial - [Benzene] equilibrium

= 4656.8941 - 4227.8354

= 429.0587 μM

$$\text{Benzene Adsolubilization } (\mu\text{mol/g alumina}) = \frac{([\text{Benzene}] \times \text{volume})/1000}{2.4}$$

$$= \frac{(429.0587 \times 120)/1000}{2.4}$$

$$= 21.4529$$

$$X_{admicelle} = \frac{\text{Mole of benzene}}{(\text{Mole of adsorbed SDS + Mole of benzene})}$$

$$X_{admicelle} = \frac{21.4529}{(585 + 21.4529)} = 0.0354$$

<u>At the supernatant</u>

Benzene concentration at equilibrium is converted to mol

$$\text{Mole of benzene} = \frac{\text{concentration} \times \text{volume}}{1000}$$

$$= \frac{(4227.8354/10^6) \times 120}{1000}$$

$$= 5.0733\text{E-}04$$

Total volume = Volume of benzene + Volume of H_2O

$$\text{Volume of benzene (ml)} = \frac{\text{mole of benzene} \times \text{MW.}}{\text{Density}}$$

$$= \frac{5.0734\text{E-}04 \times 78}{0.873}$$

$$= 0.0453$$

Volume of H_2O = Total volume - Volume of benzene

= 120 ml - 0.0453 ml

= 119.9547 ml

Assume density of water = 1 g/ml

Mass of H_2O = Volume of H_2O = 119.9547 g

Mole of H_2O = Mass of H_2O / 18 = 119.9547 / 18

= 6.6641

$$X_{bulk} = \frac{\text{Mole of benzene}}{\text{Mole of } H_2O + \text{Mole of benzene}}$$

$$= \frac{5.0733E\text{-}04}{6.6641 + 5.0733E\text{-}04}$$

$$= 7.6123E\text{-}05$$

$$K = \frac{X_{admicelle}}{X_{bulk}} = \frac{0.0354}{7.6123E\text{-}05} = 465.0368$$

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