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APPENDICES

Appendix A Adsorption of Cetyl Trimethyl Ammonium Bromide (CTAB) on Homoionic clinoptilolite

Weight of clinoptilolite = 0.2 g
Volume of CTAB solution = 20 ml
Molecular weight of CTAB = 364.45 g/mol

Table A1 Adsorption data of CTAB on clinoptilolite

| No. | Initial concentration (μM) | Equilibrium concentration (μM) | Amount of CTAB adsorbed ($\mu\text{mol/g}$ of clinoptilolite) |
|-----|--|--|---|
| 1 | 54.8772 | 12.2817 | 4.2596 |
| 2 | 164.6316 | 19.8104 | 14.3786 |
| 3 | 274.3860 | 47.7440 | 22.5876 |
| 4 | 548.7721 | 130.7666 | 44.5893 |
| 5 | 823.1582 | 329.9884 | 53.8687 |
| 6 | 1097.5442 | 486.8819 | 63.8558 |
| 7 | 1371.9303 | 670.3396 | 69.7830 |
| 8 | 1646.3163 | 916.4488 | 72.9868 |
| 9 | 1920.7024 | 1050.9661 | 86.9736 |
| 10 | 2195.0885 | 1054.4813 | 123.6373 |
| 11 | 2469.4745 | 1152.7612 | 131.6713 |
| 12 | 2743.8606 | 1178.2141 | 159.4238 |
| 13 | 3429.8258 | 1392.9165 | 197.7110 |
| 14 | 4115.7909 | 1877.7285 | 223.5611 |
| 15 | 4801.7560 | 2567.7375 | 223.4019 |
| 16 | 5487.7212 | 3097.5402 | 239.0181 |

Table A2 Zeta potential data for CTAB adsorption on clinoptilolite

| No. | Amount of CTAB adsorbed ($\mu\text{mol/g}$ of clinoptilolite) | Zeta potential (mV) |
|-----|--|---------------------|
| 1 | 4.2596 | -45.25 |
| 2 | 14.3786 | -42.79 |
| 3 | 22.5876 | -35.85 |
| 4 | 44.5893 | -21.10 |
| 5 | 53.8687 | 19.14 |
| 6 | 63.8558 | 30.02 |
| 7 | 69.7830 | 37.28 |
| 8 | 72.9868 | 42.38 |
| 9 | 86.9736 | 52.58 |
| 10 | 123.6373 | 45.77 |
| 11 | 131.6713 | 39.79 |
| 12 | 159.4238 | 49.76 |
| 13 | 197.7110 | 44.76 |
| 14 | 223.5611 | 48.02 |
| 15 | 223.4019 | 45.29 |
| 16 | 239.0181 | 51.59 |

Appendix B Adsorption of Cetyl Trimethyl Ammonium Bromide (CTAB) on Bentonite clay

Weight of bentonite clay = 0.2 g

Volume of CTAB solution = 20 ml

Molecular weight of CTAB = 364.45 g/mol

Table B1 Adsorption data of CTAB on bentonite clay

| No. | Initial concentration (μM) | Equilibrium concentration (μM) | Amount of CTAB adsorbed ($\mu\text{mol/g}$ of bentonite clay) |
|-----|--|--|---|
| 1 | 27.4386 | 2.7439 | 17.0000 |
| 2 | 68.5965 | 19.2070 | 67.0000 |
| 3 | 137.1930 | 41.1579 | 128.7500 |
| 4 | 274.3861 | 63.1088 | 336.0000 |
| 5 | 548.7721 | 68.5965 | 360.0000 |
| 6 | 685.9652 | 72.7123 | 448.5000 |
| 7 | 1097.5440 | 100.1509 | 489.7500 |
| 8 | 1371.9300 | 103.3612 | 532.5000 |
| 9 | 3429.8260 | 109.7544 | 573.5000 |
| 10 | 4527.3700 | 112.4983 | 655.0000 |
| 11 | 4938.9490 | 116.1476 | 677.6700 |
| 12 | 5350.5280 | 137.1930 | 692.5000 |
| 13 | 5556.3180 | 150.9123 | 734.0000 |
| 14 | 5762.1070 | 152.7507 | 851.0000 |
| 15 | 6173.6860 | 174.2351 | 981.0000 |
| 16 | 6585.2650 | 178.3509 | 1019.6700 |
| 17 | 6791.0550 | 185.2106 | 1098.0000 |
| 18 | 6859.6520 | 257.0174 | 1221.0000 |
| 19 | 6996.8450 | 373.1650 | 1359.6700 |
| 20 | 7408.4240 | 411.5791 | 1400.0000 |
| 21 | 8643.1610 | 768.281 | 1580.0000 |
| 22 | 9877.8980 | 960.3512 | 1650.0000 |
| 23 | 10289.4800 | 1371.93 | 1700.0000 |

Table B1 Adsorption data of CTAB on bentonite clay (con't)

| No. | Initial concentration (μM) | Equilibrium concentration (μM) | Amount of CTAB adsorbed ($\mu\text{mol/g}$ of bentonite clay) |
|-----|--|--|---|
| 24 | 11112.6400 | 1838.3870 | 1786.0000 |
| 25 | 12347.3700 | 2195.0880 | 1790.0000 |
| 26 | 13719.3000 | 2892.0290 | 1792.0000 |
| 27 | 15434.2200 | 3347.5100 | 1792.5000 |
| 28 | 17149.1300 | 3621.8960 | 1793.0000 |

Table B2 Zeta potential data for CTAB adsorption on bentonite clay

| No. | Amount of CTAB adsorbed ($\mu\text{mol/g}$ of bentonite) | Zeta potential (mV) |
|-----|---|---------------------|
| 1 | 14.0000 | -56.61 |
| 2 | 67.0000 | -49.45 |
| 3 | 110.0000 | -48.42 |
| 4 | 128.7500 | -41.80 |
| 5 | 200.0000 | -35.50 |
| 6 | 280.0000 | -23.94 |
| 7 | 336.0000 | -19.75 |
| 8 | 360.0000 | -15.20 |
| 9 | 448.5000 | 8.18 |
| 10 | 489.7500 | 24.45 |
| 11 | 532.5000 | 31.12 |
| 12 | 573.5000 | 38.00 |
| 13 | 655.0000 | 44.00 |
| 14 | 677.6700 | 50.00 |

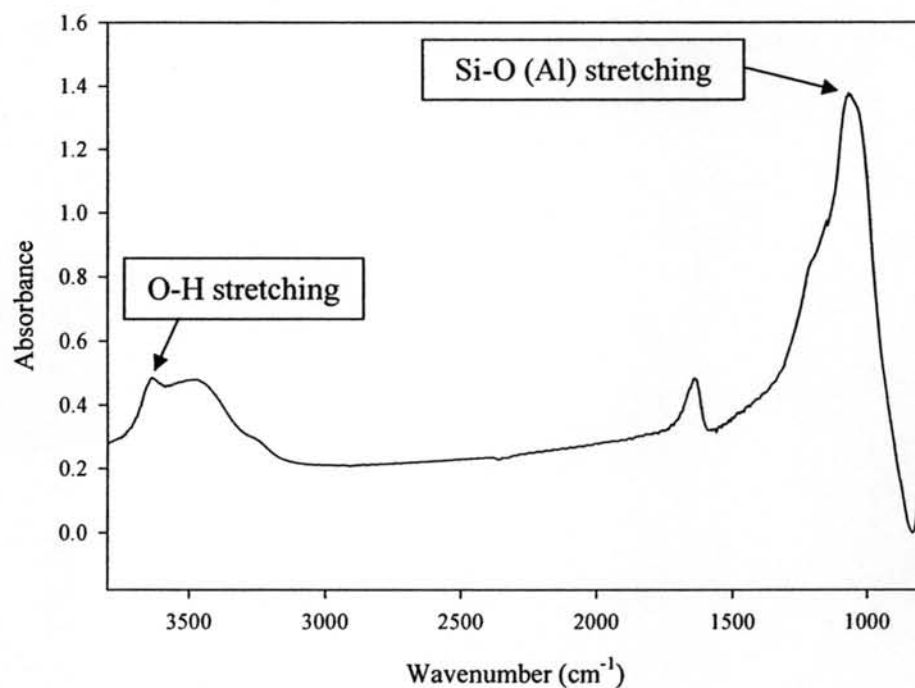


Figure A1 FTIR spectra of clinoptililite

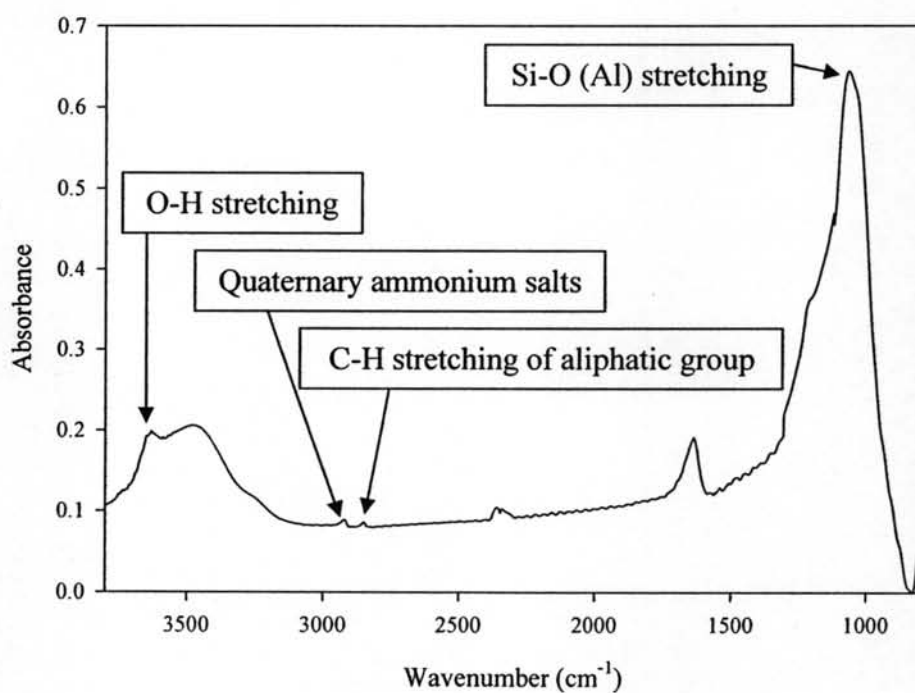


Figure A2 FTIR spectra of CTAB-modified clinoptililite

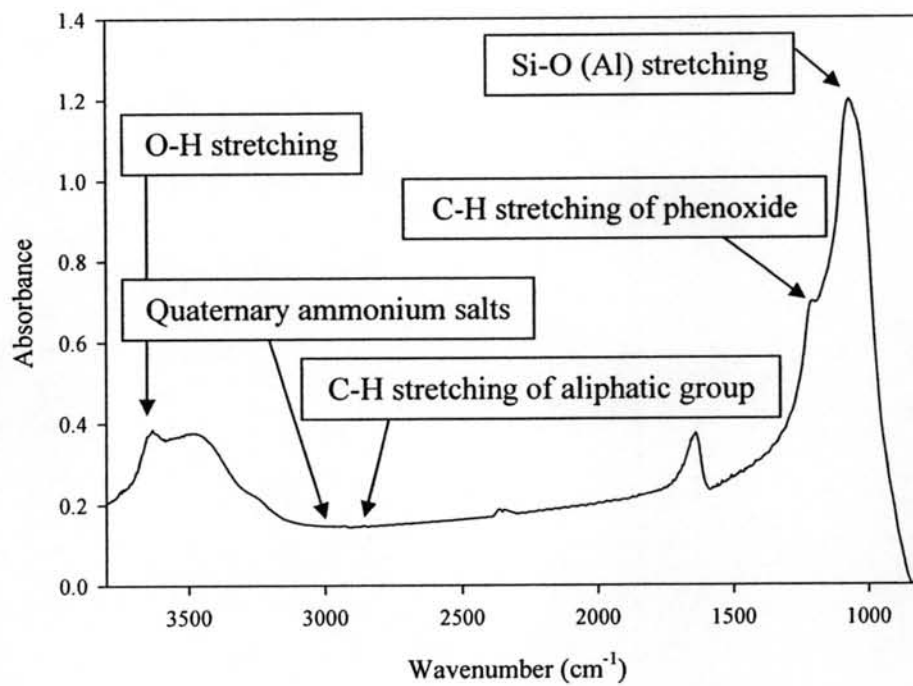


Figure A3 FTIR spectra of SMZ

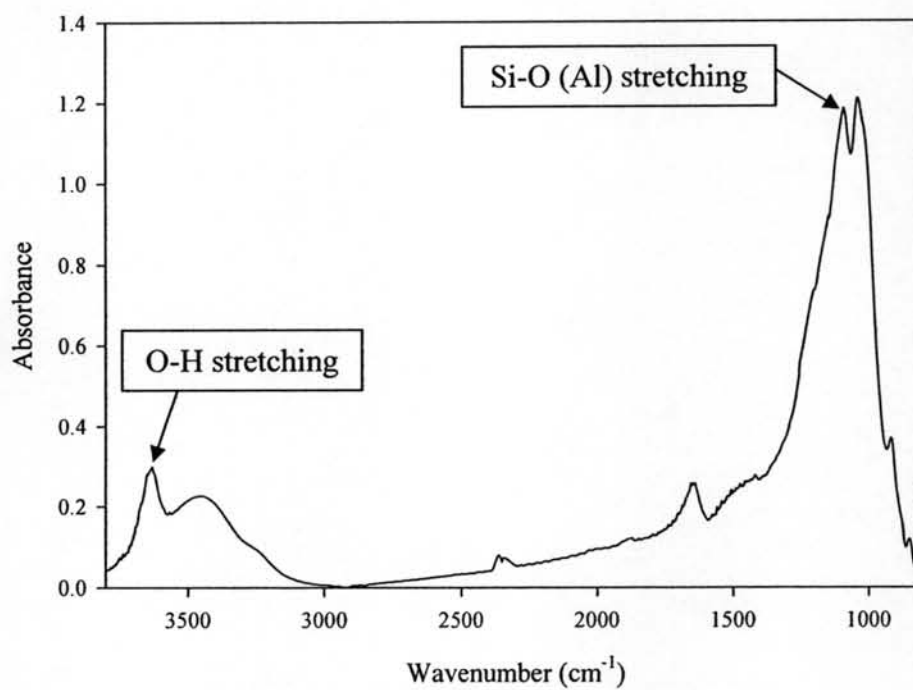


Figure A4 FTIR spectra of bentonite

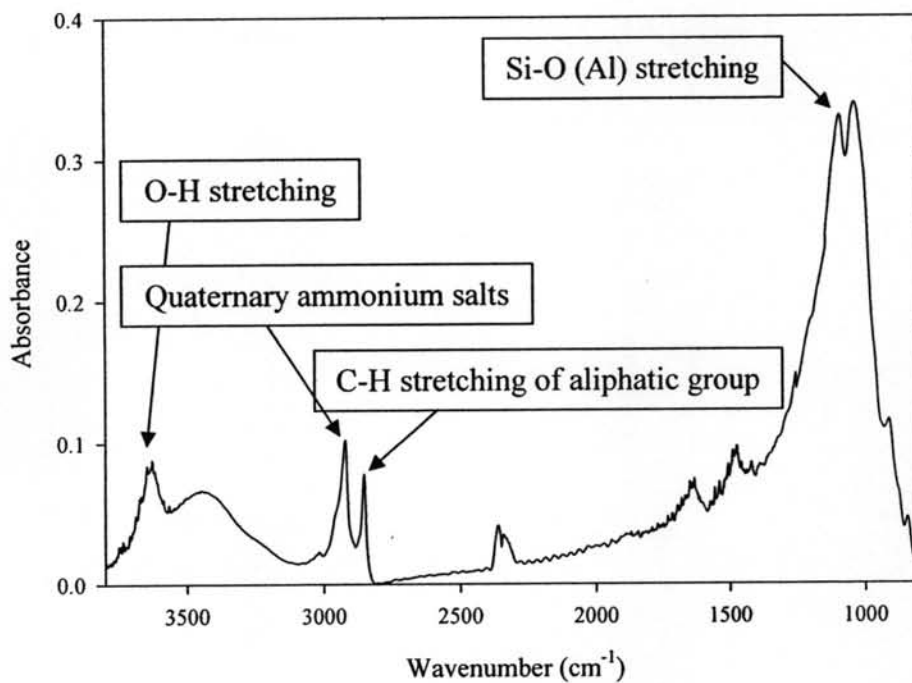


Figure A5 FTIR spectra of CTAB-modified bentonite

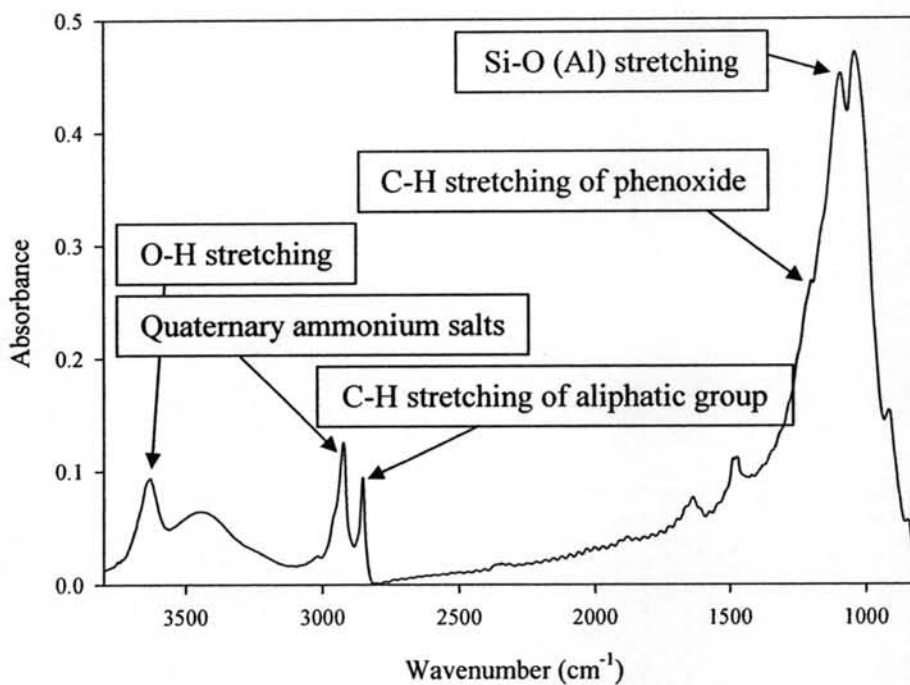


Figure A6 FTIR spectra of SMB

Appendix C Adsorption of Cadmium on Surfactant-Modified Adsorbents (SMADs) in Single-Solute System

Homoionic clinoptilolite and SMZ

Weight of adsorbent = 0.2 gram

Volume cadmium solution = 20 ml

Table C1 Adsorption data of cadmium on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) |
| 1 | 0.4448 | 0.0082 | 0.0036 | 0.0022 | 0.0201 |
| 2 | 0.8897 | 0.0164 | 0.0072 | 0.0145 | 0.0435 |
| 3 | 1.3345 | 0.0848 | 0.1163 | 0.0714 | 0.0824 |
| 4 | 1.7793 | 0.2069 | 0.1626 | 0.1659 | 0.1211 |
| 5 | 2.2242 | 0.3652 | 0.1924 | 0.3707 | 0.1484 |
| 6 | 2.6690 | 0.6028 | 0.2092 | 0.5144 | 0.1766 |
| 7 | 3.1139 | 0.9378 | 0.2249 | 0.7954 | 0.1963 |
| 8 | 3.5587 | 1.3710 | 0.2395 | 1.9395 | 0.1925 |
| 9 | 4.0036 | 1.7933 | 0.2484 | 2.7376 | 0.2067 |
| 10 | 4.4484 | 2.6563 | 0.2695 | 3.8022 | 0.2095 |

Bentonite clay and SMB

Weight of adsorbent = 0.2 gram

Volume of cadmium solution = 20 ml

Table C2 Adsorption data of cadmium on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) |
| 1 | 0.8897 | 0.0882 | 0.01213 | 0.1800 | 0.0018 |
| 2 | 1.3345 | 0.1324 | 0.0182 | 0.2699 | 0.0028 |
| 3 | 1.7794 | 0.1765 | 0.0243 | 0.6581 | 0.0072 |
| 4 | 2.2242 | 0.2206 | 0.0303 | 0.8432 | 0.0093 |
| 5 | 2.6690 | 0.4840 | 0.0421 | 1.4526 | 0.0142 |
| 6 | 3.1139 | 0.8027 | 0.0672 | 1.8617 | 0.0161 |
| 7 | 3.5587 | 1.4842 | 0.1374 | 2.2946 | 0.0189 |
| 8 | 4.0036 | 2.5884 | 0.1928 | 2.7475 | 0.0204 |
| 9 | 4.4484 | 2.8896 | 0.2255 | 3.0257 | 0.0217 |
| 10 | 5.3381 | 3.4522 | 0.2456 | 4.5114 | 0.0239 |
| 11 | 6.2278 | 4.4036 | 0.2938 | 4.9738 | 0.0262 |
| 12 | 7.1174 | 5.4063 | 0.3278 | 5.8829 | 0.0282 |
| 13 | 8.0071 | 6.0435 | 0.3529 | 6.7593 | 0.0308 |
| 14 | 8.8968 | 6.5172 | 0.3662 | 7.8174 | 0.0337 |

Appendix D Adsorption of Organic Compounds on Surfactant-Modified Adsorbents (SMADs) in Single-Solute System

Homoionic clinoptilolite and SMZ

Weight of adsorbent = 0.2 gram

Volume of organics solution = 20 ml

Table D1 Adsorption data of benzene on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) |
| 1 | 0.4796 | 0.3342 | 0.0065 | 0.2759 | 0.0155 |
| 2 | 0.9592 | 0.7044 | 0.0043 | 0.6295 | 0.0262 |
| 3 | 1.9185 | 1.7057 | 0.0058 | 1.1350 | 0.0740 |
| 4 | 3.8370 | 3.5901 | 0.0116 | 2.3671 | 0.1322 |
| 5 | 5.7554 | 5.3984 | 0.0174 | 3.8160 | 0.2002 |
| 6 | 7.6740 | 6.3596 | 0.0345 | 5.1803 | 0.2314 |
| 7 | 9.5924 | 9.1211 | 0.0453 | 6.1971 | 0.3147 |
| 8 | 11.9906 | 10.0307 | 0.0540 | 8.4412 | 0.3614 |
| 9 | 14.3887 | 11.9418 | 0.0648 | 10.6256 | 0.4593 |
| 10 | 19.1849 | 18.0175 | 0.0722 | 14.2707 | 0.5906 |

Table D2 Adsorption data of benzoic acid on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|--|--------------------------------|--|
| | | Equilibrium concentration (mM) | Amount of benzoic acid adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzoic acid adsorbed (mmol/g) |
| 1 | 0.0893 | 0.1118 | 9E-05 | 0.0781 | 0.0011 |
| 2 | 0.1786 | 0.1911 | 0.0002 | 0.1602 | 0.0018 |
| 3 | 0.3571 | 0.3544 | 0.0003 | 0.3052 | 0.0052 |
| 4 | 0.5357 | 0.5274 | 0.0008 | 0.4745 | 0.0061 |
| 5 | 0.7143 | 0.7200 | 0.0016 | 0.6259 | 0.0088 |
| 6 | 0.8929 | 0.8670 | 0.00091 | 0.7969 | 0.0096 |
| 7 | 1.0714 | 1.0346 | 0.0014 | 0.9549 | 0.0116 |
| 8 | 1.2500 | 1.2261 | 0.0024 | 1.1331 | 0.0117 |
| 9 | 1.4286 | 1.3774 | 0.0026 | 1.2823 | 0.0146 |
| 10 | 1.7857 | 1.7369 | 0.0049 | 1.6064 | 0.0179 |

Table D3 Adsorption data of phenol on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|
| | | Equilibrium concentration (mM) | Amount of phenol adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of phenol adsorbed (mmol/g) |
| 1 | 2.1224 | 2.0822 | 0.0035 | 1.9834 | 0.0137 |
| 2 | 4.2449 | 4.1644 | 0.0070 | 3.8882 | 0.0354 |
| 3 | 8.4899 | 8.3884 | 0.0081 | 7.9258 | 0.0558 |
| 4 | 12.7349 | 12.4823 | 0.0061 | 11.9065 | 0.0819 |
| 5 | 16.9799 | 17.0331 | 0.0087 | 15.8987 | 0.1069 |
| 6 | 21.2248 | 21.4919 | 0.0109 | 19.7296 | 0.1480 |
| 7 | 26.5310 | 26.3278 | 0.0140 | 24.8533 | 0.1658 |
| 8 | 31.8372 | 31.6035 | 0.0158 | 29.5009 | 0.2313 |
| 9 | 37.1434 | 37.3050 | 0.0186 | 34.5764 | 0.2540 |
| 10 | 42.4496 | 42.1558 | 0.0193 | 39.4229 | 0.2995 |

Table D4 Adsorption data of chlorobenzene on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|---|--------------------------------|---|
| | | Equilibrium concentration (mM) | Amount of chlorobenzene sorbed (mmol/g) | Equilibrium concentration (mM) | Amount of chlorobenzene sorbed (mmol/g) |
| 1 | 0.0778 | 0.0751 | 0.0023 | 0.0690 | 0.0034 |
| 2 | 0.1555 | 0.1626 | 0.0006 | 0.1374 | 0.0081 |
| 3 | 0.3887 | 0.3743 | 0.0013 | 0.3360 | 0.0243 |
| 4 | 0.6997 | 0.6640 | 0.0031 | 0.628 | 0.0403 |
| 5 | 1.0885 | 1.0573 | 0.0024 | 0.9679 | 0.0654 |
| 6 | 1.4772 | 1.4225 | 0.0046 | 1.2896 | 0.0901 |
| 7 | 1.7882 | 1.7628 | 0.0074 | 1.4491 | 0.1075 |
| 8 | 2.2547 | 2.2677 | 0.0093 | 1.9684 | 0.1356 |
| 9 | 2.7212 | 2.6204 | 0.0084 | 2.3756 | 0.1636 |
| 10 | 3.1099 | 2.9617 | 0.0096 | 2.7150 | 0.1876 |

Table D5 Adsorption data of naphthalene on homoionic clinoptilolite and SMZ

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|---|--------------------------------|---|
| | | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) |
| 1 | 0.0012 | 0.0012 | 9.01364E-06 | 0.0011 | 2.9410E-05 |
| 2 | 0.0050 | 0.0048 | 2.82524E-05 | 0.0044 | 0.0001 |
| 3 | 0.0087 | 0.0086 | 3.42276E-05 | 0.0077 | 0.0002 |
| 4 | 0.0124 | 0.0123 | 3.55214E-05 | 0.0110 | 0.0003 |
| 5 | 0.0150 | 0.0148 | 3.0142E-05 | 0.0132 | 0.0004 |
| 6 | 0.0175 | 0.0173 | 3.2565E-05 | 0.0154 | 0.0004 |
| 7 | 0.0187 | 0.0185 | 4.1579E-05 | 0.0165 | 0.0004 |
| 8 | 0.0212 | 0.0211 | 2.8398E-05 | 0.0187 | 0.0005 |
| 9 | 0.0225 | 0.0222 | 5.3016E-05 | 0.0198 | 0.0005 |

Table D5 Adsorption data of naphthalene on homoionic clinoptilolite and SMZ
(con't)

| No. | Initial concentration (mM) | Homoionic clinoptilolite | | SMZ | |
|-----|----------------------------|--------------------------------|---|--------------------------------|---|
| | | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) |
| 10 | 0.0250 | 0.0248 | 3.2032E-05 | 0.0222 | 0.00054 |

Bentonite clay and SMB

Weight of adsorbent = 0.2 gram

Volume of organics solution = 20 ml

Table D6 Adsorption data of benzene on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) |
| 1 | 37.4100 | 0.1164 | 0.0198 | 0.1189 | 0.0747 |
| 2 | 74.8200 | 0.2329 | 0.0040 | 0.2258 | 0.1430 |
| 3 | 149.6400 | 0.4658 | 0.0079 | 0.4503 | 0.2873 |
| 4 | 299.2800 | 3.7262 | 0.0209 | 0.9075 | 0.5847 |
| 5 | 448.9200 | 5.5893 | 0.0313 | 1.4321 | 0.8629 |
| 6 | 598.5600 | 7.4525 | 0.0417 | 1.8976 | 1.1529 |
| 7 | 748.2000 | 9.3156 | 0.0521 | 2.3720 | 1.4411 |
| 8 | 935.2500 | 11.6445 | 0.0652 | 2.9650 | 1.8014 |
| 9 | 1122.3000 | 13.9734 | 0.0782 | 3.5271 | 2.1678 |
| 10 | 1496.4000 | 18.6312 | 0.1043 | 4.4818 | 2.9470 |

Table D7 Adsorption data of benzoic acid on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|--|--------------------------------|--|
| | | Equilibrium concentration (mM) | Amount of benzoic acid adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzoic acid adsorbed (mmol/g) |
| 1 | 0.0818 | 0.0739 | 0.0016 | 0.0437 | 0.0076 |
| 2 | 0.1637 | 0.1606 | 0.0006 | 0.1003 | 0.0127 |
| 3 | 0.3273 | 0.3109 | 0.0033 | 0.1810 | 0.0293 |
| 4 | 0.4910 | 0.4626 | 0.0057 | 0.2729 | 0.0436 |
| 5 | 0.6547 | 0.6374 | 0.0035 | 0.4299 | 0.0549 |
| 6 | 0.8183 | 0.7966 | 0.0043 | 0.5281 | 0.0581 |
| 7 | 0.9820 | 0.9252 | 0.0520 | 0.6590 | 0.0646 |
| 8 | 1.1457 | 1.1359 | 0.0020 | 0.7975 | 0.0696 |
| 9 | 1.3093 | 1.2746 | 0.0069 | 0.9055 | 0.0807 |
| 10 | 1.6367 | 1.5934 | 0.0087 | 1.1120 | 0.0849 |

Table D8 Adsorption data of phenol on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|
| | | Equilibrium concentration (mM) | Amount of phenol adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of phenol adsorbed (mmol/g) |
| 1 | 2.1251 | 2.1248 | 7.9701E-05 | 1.7251 | 0.0800 |
| 2 | 4.2503 | 4.2499 | 8.2356E-05 | 3.4039 | 0.1693 |
| 3 | 8.5007 | 8.5002 | 8.7663E-05 | 7.0956 | 0.2810 |
| 4 | 12.7510 | 12.7506 | 9.2974E-05 | 10.9442 | 0.3614 |
| 5 | 17.0019 | 17.0009 | 9.8284E-05 | 14.8419 | 0.4319 |
| 6 | 21.2517 | 21.2512 | 0.0001 | 19.0313 | 0.4441 |
| 7 | 26.5647 | 26.5641 | 0.0001 | 23.9852 | 0.5159 |
| 8 | 31.8776 | 31.8770 | 0.0001 | 29.0490 | 0.5657 |
| 9 | 37.1905 | 37.1899 | 0.0001 | 33.9850 | 0.6411 |
| 10 | 42.5034 | 42.5028 | 0.0001 | 39.1195 | 0.6768 |

Table D9 Adsorption data of chlorobenzene on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|---|--------------------------------|---|
| | | Equilibrium concentration (mM) | Amount of chlorobenzene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of chlorobenzene adsorbed (mmol/g) |
| 1 | 8.7500 | 0.0772 | 0.0083 | 0.0087 | 0.0104 |
| 2 | 17.5000 | 0.1544 | 0.0032 | 0.0241 | 0.0221 |
| 3 | 43.7500 | 0.3861 | 0.0080 | 0.0487 | 0.0489 |
| 4 | 78.7500 | 0.6950 | 0.0010 | 0.0761 | 0.1001 |
| 5 | 122.5000 | 1.0811 | 0.0016 | 0.1034 | 0.1394 |
| 6 | 166.2500 | 1.4672 | 0.0021 | 0.1604 | 0.2162 |
| 7 | 201.2500 | 1.7761 | 0.0025 | 0.1767 | 0.2371 |
| 8 | 253.7500 | 2.2394 | 0.0032 | 0.2280 | 0.3050 |
| 9 | 306.2500 | 2.7027 | 0.0039 | 0.3041 | 0.4642 |
| 10 | 350.0000 | 3.0888 | 0.0044 | 0.3250 | 0.5459 |

Table D10 Adsorption data of naphthalene on bentonite clay and SMB

| No. | Initial concentration (mM) | Bentonite clay | | SMB | |
|-----|----------------------------|--------------------------------|---|--------------------------------|---|
| | | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of naphthalene adsorbed (mmol/g) |
| 1 | 0.1600 | 0.0011 | 1.3456E-05 | 4.9168E-05 | 0.0001 |
| 2 | 0.6400 | 0.0047 | 3.0419E-05 | 0.0003 | 0.0005 |
| 3 | 1.1200 | 0.0084 | 3.1778E-05 | 0.0006 | 0.0008 |
| 4 | 1.6000 | 0.0120 | 5.2642E-05 | 0.0009 | 0.0012 |
| 5 | 1.9200 | 0.0142 | 7.5653E-05 | 0.0011 | 0.0014 |
| 6 | 2.2400 | 0.0170 | 4.4050E-05 | 0.0017 | 0.0016 |
| 7 | 2.4000 | 0.0182 | 4.9704E-05 | 0.0020 | 0.0017 |
| 8 | 2.7200 | 0.0208 | 4.5409E-05 | 0.0025 | 0.0019 |
| 9 | 2.8800 | 0.0219 | 5.8865E-05 | 0.0029 | 0.0020 |
| 10 | 3.2000 | 0.0244 | 5.8470E-05 | 0.0034 | 0.0022 |

Appendix E Adsorption Experiments of Cadmium on Surfactant-Modified Adsorbents (SMADs) in Single-solute and Mixed-Solute System

SMZ

Weight of adsorbent = 0.2 gram

Volume of cadmium solution = 20 ml

Table E1 Adsorption data of cadmium on SMZ in single-solute system and mixed-solute system

| No. | Initial concentration (mM) | SMZ in single-solute system | | SMZ in mixed-solute system | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) |
| 1 | 0.4448 | 3.8022 | 0.2095 | 2.5933 | 0.1771 |
| 2 | 0.8897 | 2.7376 | 0.2067 | 1.6137 | 0.1718 |
| 3 | 1.3345 | 1.9395 | 0.1926 | 1.2149 | 0.1678 |
| 4 | 1.7794 | 0.7954 | 0.1963 | 0.9231 | 0.1586 |
| 5 | 2.2242 | 0.5144 | 0.1766 | 0.6221 | 0.1552 |
| 6 | 2.6690 | 0.3707 | 0.1484 | 0.3946 | 0.1336 |
| 7 | 3.1139 | 0.1659 | 0.1211 | 0.2467 | 0.1140 |
| 8 | 3.5587 | 0.0714 | 0.0824 | 0.1567 | 0.1078 |
| 9 | 4.0036 | 0.0145 | 0.0435 | 0.0613 | 0.0958 |
| 10 | 4.4484 | 0.0022 | 0.0201 | 0.0146 | 0.0352 |

SMB

Weight of adsorbent = 0.2 gram

Volume of cadmium solution = 20 ml

Table E2 Adsorption data of cadmium on SMB in single-solute system and mixed-solute system

| No. | Initial concentration (mM) | SMB in single-solute system | | SMB in mixed-solute system | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of cadmium adsorbed (mmol/g) |
| 1 | 0.4448 | 3.8022 | 0.2095 | 2.5933 | 0.1771 |
| 2 | 0.8897 | 2.7376 | 0.2067 | 1.6137 | 0.1718 |
| 3 | 1.3345 | 1.9395 | 0.1926 | 1.2149 | 0.1678 |
| 4 | 1.7794 | 0.7954 | 0.1963 | 0.9231 | 0.1586 |
| 5 | 2.2242 | 0.5144 | 0.1766 | 0.6221 | 0.1552 |
| 6 | 2.6690 | 0.3707 | 0.1484 | 0.3946 | 0.1336 |
| 7 | 3.1139 | 0.1659 | 0.1211 | 0.2467 | 0.1140 |
| 8 | 3.5587 | 0.0714 | 0.0824 | 0.1567 | 0.1078 |
| 9 | 4.0036 | 0.0145 | 0.0435 | 0.0613 | 0.0958 |
| 10 | 4.4484 | 0.0022 | 0.0201 | 0.0146 | 0.0352 |

**Appendix F Adsorption of Organic Compounds on Surfactant-Modified
Adsorbent (SMADs) in Single-Solute and Mixed-Solute System**

SMZ

Weight of adsorbent = 0.2 gram

Volume of organics solution = 20 ml

Table F1 Adsorption data of benzene on SMZ in single-solute system and mixed-solute system

| No. | Initial concentration (mM) | SMZ in single-solute system | | SMZ in mixed-solute system | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) |
| 1 | 19.1849 | 14.2708 | 0.5906 | 13.4085 | 0.5823 |
| 2 | 14.3887 | 10.6256 | 0.4593 | 12.0643 | 0.5077 |
| 3 | 11.9906 | 8.4412 | 0.3614 | 10.6686 | 0.4195 |
| 4 | 9.5924 | 6.1971 | 0.3147 | 9.0357 | 0.3507 |
| 5 | 7.6740 | 5.1803 | 0.2314 | 7.5619 | 0.2774 |
| 6 | 5.7555 | 3.8160 | 0.2002 | 5.9654 | 0.2096 |
| 7 | 3.8370 | 2.3672 | 0.1322 | 3.7959 | 0.1315 |
| 8 | 1.9185 | 1.1350 | 0.0741 | 2.7342 | 0.1229 |
| 9 | 0.9592 | 0.6295 | 0.0262 | 1.4674 | 0.0336 |
| 10 | 0.4796 | 0.2759 | 0.0155 | 0.75841 | 0.0197 |

SMB

Weight of adsorbent = 0.2 gram

Volume of organics solution = 20 ml

Table F2 Adsorption data of benzene on SMB in single-solute system and mixed-solute system

| No. | Initial concentration (mM) | SMB in single-solute system | | SMB in mixed-solute system | |
|-----|----------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------------|
| | | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) | Equilibrium concentration (mM) | Amount of benzene adsorbed (mmol/g) |
| 1 | 19.1849 | 4.4818 | 2.9470 | 4.2448 | 2.6369 |
| 2 | 14.3887 | 3.5271 | 2.1678 | 3.6841 | 2.2942 |
| 3 | 11.9906 | 2.96503 | 1.8014 | 3.2177 | 1.7991 |
| 4 | 9.5924 | 2.3720 | 1.4411 | 2.7259 | 1.5466 |
| 5 | 7.6740 | 1.8976 | 1.1529 | 2.1452 | 1.1657 |
| 6 | 5.7555 | 1.4321 | 0.8629 | 1.6333 | 0.9272 |
| 7 | 3.8370 | 0.9075 | 0.5847 | 1.2871 | 0.8428 |
| 8 | 1.9185 | 0.4503 | 0.2873 | 0.8581 | 0.68051 |
| 9 | 0.9592 | 0.2258 | 0.1430 | 0.3341 | 0.1163 |
| 10 | 0.4796 | 0.1189 | 0.0747 | 0.1440 | 0.0634 |

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