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APPENDICES

Appendix A Adsorption Capacity of MP-PCH

The adsorption capacity of MP-PCH were obtained from ICP-OES data. The 0.05 g of the adsorbent was srirred in the 100 mL of standard heavy metal solution at room temperature which varied pH of standard solution and contact time. The initial and final concentration of the standard heavy metal solution was measured by using ICP-OES. The adsorption capacity of each element was calculated from this equation.

Adsorption Capacity (q)

$$q = \frac{(Ci - Ce)V}{W}$$

where:

C_i = initial concentration of standard heavy metal solution
C_e = final or equilibrium concentration of standard heavy metal solution
V = volumn of solution
W = weight of the adsorbent

Table A1 Adsorption Capacities of MP-PCH for heavy metal at pH 3

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.079	0.077	0.075	0.075	0.002
Ni	0.068	0.062	0.065	0.065	0.003
Cu	0.026	0.038	0.032	0.032	0.006
Cd	0.032	0.037	0.035	0.035	0.0025
Pb	0.011	0.016	0.015	0.014	0.0026

Table A2 Adsorption Capacities of MP-PCH for heavy metal at pH 5

Elements	Adsorption Capacity of MP-PCH(mmol/g).				
	1st time	2nd time	3rd time	Average	SD
Mn	0.340	0.332	0.331	0.334	0.005
Ni	0.282	0.279	0.285	0.282	0.003
Cu	0.185	0.189	0.189	0.188	0.002
Cd	0.125	0.125	0.125	0.125	0
Pb	0.059	0.061	0.059	0.060	0.001

Table A3 Adsorption Capacities of MP-PCH for heavy metal at pH 7

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.372	0.370	0.370	0.371	0.001
Ni	0.352	0.352	0.351	0.352	0.0006
Cu	0.188	0.188	0.189	0.188	0.0006
Cd	0.171	0.171	0.171	0.171	0
Pb	0.099	0.098	0.098	0.098	0.0006

Table A4 Adsorption Capacities of MP-PCH for heavy metal at pH 9

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.317	0.315	0.315	0.316	0.001
Ni	0.353	0.353	0.353	0.353	0
Cu	0.139	0.138	0.139	0.139	0.001
Cd	0.178	0.166	0.176	0.174	0.006
Pb	0.100	0.098	0.098	0.099	0.001

Table A5 Adsorption Capacities of MP-PCH for heavy metal at pH 7 and using contact time 4 hr

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.137	0.141	0.141	0.140	0.002
Ni	0.132	0.141	0.143	0.139	0.006
Cu	0.077	0.083	0.082	0.081	0.003
Cd	0.074	0.072	0.069	0.072	0.003
Pb	0.039	0.029	0.032	0.033	0.005

Table A6 Adsorption Capacities of MP-PCH for heavy metal at pH 7 and using contact time 12 hr

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.328	0.327	0.328	0.328	0.0006
Ni	0.353	0.359	0.360	0.357	0.004
Cu	0.243	0.240	0.240	0.241	0.002
Cd	0.173	0.173	0.171	0.172	0.001
Pb	0.100	0.100	0.101	0.100	0.0006

Table A7 Adsorption Capacities of MP-PCH for heavy metal at pH 7 and using contact time 12 hr

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.328	0.327	0.328	0.328	0.0006
Ni	0.353	0.359	0.360	0.357	0.004
Cu	0.243	0.240	0.240	0.241	0.002
Cd	0.173	0.173	0.171	0.172	0.001
Pb	0.100	0.100	0.101	0.100	0.0006

Table A8 Adsorption Capacities of MP-PCH for heavy metal at pH 7 and using contact time 24 hr

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.506	0.506	0.506	0.506	0
Ni	0.483	0.483	0.482	0.483	0.001
Cu	0.239	0.234	0.239	0.237	0.003
Cd	0.224	0.224	0.223	0.224	0.001
Pb	0.116	0.116	0.116	0.116	0

Table A9 Adsorption Capacities of MP-PCH for heavy metal at pH 7 and using contact time 48 hr

Elements	Adsorption Capacity of MP-PCH(mmol/g)				
	1st time	2nd time	3rd time	Average	SD
Mn	0.498	0.503	0.504	0.502	0.003
Ni	0.484	0.484	0.484	0.484	0
Cu	0.237	0.237	0.236	0.237	0.001
Cd	0.219	0.223	0.223	0.222	0.002
Pb	0.110	0.115	0.113	0.113	0.003

Appendix B Adsorption Capacity of DM-PCH

High Performance Liquid Chromatography (HPLC) with UV-Visible detector was utilized to investigate adsorption capacity of DM-PCH. The adsorbent was stirred with organics solution which varied concentration and contact time and then the concentration of organic solution was measured by HPLC. The adsorption capacities of DM-PCH was calculated by taking the same equation with MP-PCH.

Table B1 Relationship between concentration and peak area of 4-chloroguaiacol

Concentration (mM)	Peak area				
	1st time	2nd time	3rd time	Average	SD
0.2	116205	116211	116210	116209	3.2145
0.4	198769	198763	198762	198765	3.7859
0.6	298003	298001	297997	298000	3.0505
0.8	389760	389761	389759	389760	1.0000
1.0	490051	490049	490054	490051	2.5166

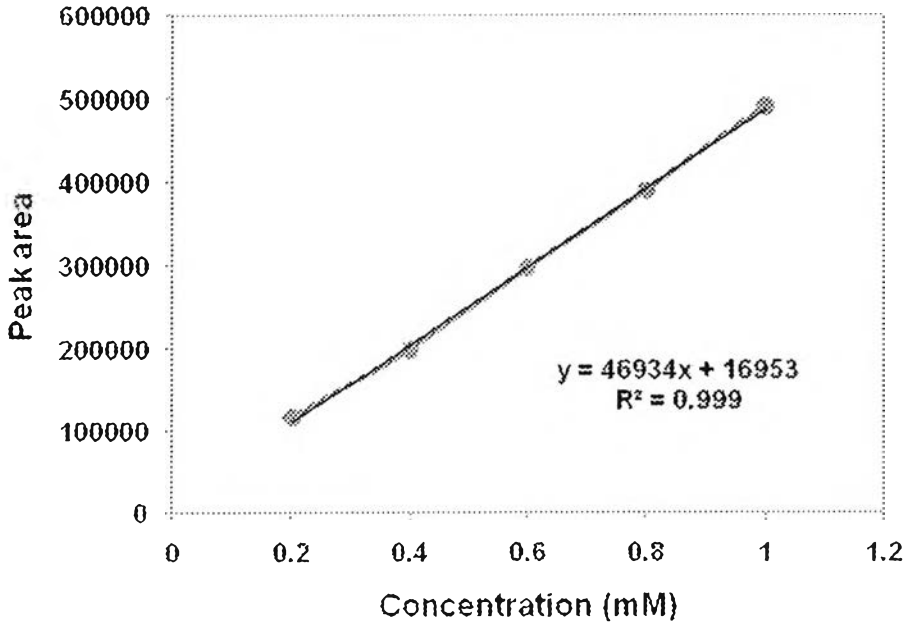

Figure B1 Standard curve of 4-chloroguaiacol

Table B2 Adsorption Capacities of DM-PCH for 4-chloroguaiacol at varied concentration

Concentration (mM)	Adsorption Capacity of DM-PCH(mM/g)				
	1st time	2nd time	3rd time	Average	SD
0.20	0.201	0.201	0.200	0.201	0.0006
0.40	2.805	2.803	2.796	2.801	0.005
0.60	2.511	2.510	2.510	2.510	0.0006
0.80	1.806	1.806	1.808	1.807	0.001

Table B3 Adsorption Capacities of DM-PCH for 4-chloroguaiacol at concentration 0.4 mM and varied contact time

Contact time (hr)	Adsorption Capacity of DM-PCH(mM/g)				
	1st time	2nd time	3rd time	Average	SD
4	2.103	2.097	2.101	2.100	0.003
12	3.216	3.219	3.216	3.217	0.002
24	3.620	3.613	3.611	3.615	0.005
48	3.614	3.615	3.615	3.615	0.0006

Table B4 Relationship between concentration and peak area of 2,6-dinitrophenol

Concentration (mM)	Peak area				
	1st time	2nd time	3rd time	Average	SD
0.20	85094	85100	85100	85098	3.4641
0.40	167656	167649	167652	167652	3.5119
0.60	266889	266887	266886	266887	1.5275
0.80	358649	358650	358648	358649	1.0000
1.00	458940	458938	458942	458940	2.0000

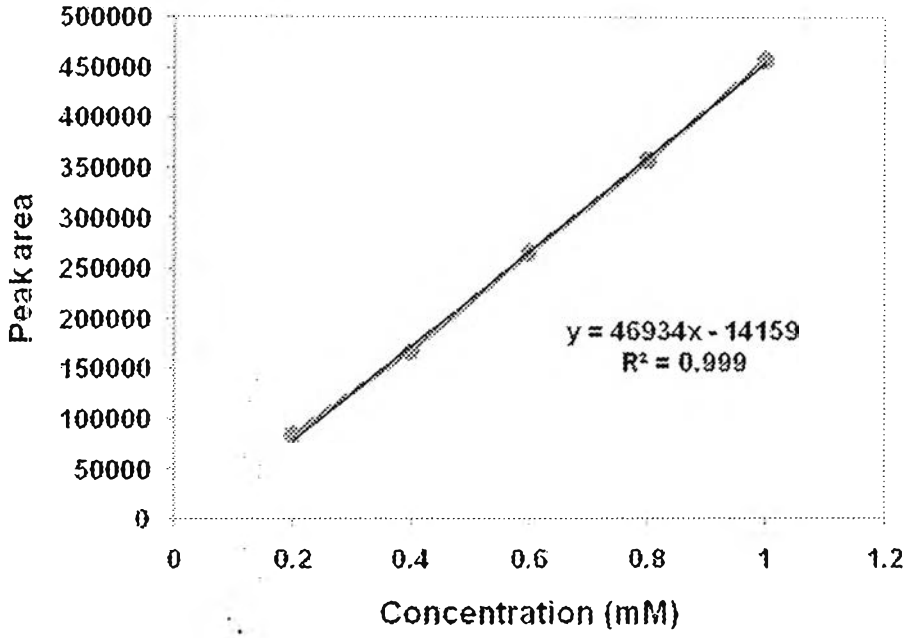

Figure B2 Standard curve of 2,6-dinitrophenol

Table B5 Adsorption Capacities of DM-PCH for 2,6-dinitrophenol at varied concentration

Concentration (mM)	Adsorption Capacity of DM-PCH(mM/g)				
	1st time	2nd time	3rd time	Average	SD
0.20	0.001	0.000	0.000	0.000	0.0006
0.40	1.319	1.309	1.311	1.314	0.005
0.60	1.501	1.505	1.502	1.503	0.002
0.80	1.320	1.313	1.315	1.316	0.004

Table B6 Adsorption Capacities of DM-PCH for 2,6-dinitrophenol at concentration 0.4 mM and varied contact time

Contact time (hr)	Adsorption Capacity of DM-PCH(mM/g)				
	1st time	2nd time	3rd time	Average	SD
4	0.099	0.100	0.100	0.100	0.0006
12	1.218	1.211	1.211	1.213	0.004
24	1.436	1.435	1.436	1.436	0.0006
48	1.438	1.436	1.436	1.436	0.001

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2. Tassanapayak, R., Magaraphan, R., and Manuspiya, H. (2008, April 22-25) Functionalized Porous Clay Heterostructure for Heavy Metal Removal. Proceedings of Smartmat-'08 & IWOFM-2, Chiang Mai, Thailand.

Presentations:

1. Tassanapayak, R., Magaraphan, R., and Manuspiya, H. (2008, April 23) Porous Clay Heterostructures for Wastewater Treatment: A Development from Bentonite Clay in Thailand. Poster presented at the 14th PPC Symposium on Petroleum, Petrochems, and Polymers, Bangkok, Thailand.
2. Tassanapayak, R., Magaraphan, R., and Manuspiya, H. (2008, April 22-25) Porous Clay Heterostructures for Wastewater Treatment: A Development from Bentonite Clay in Thailand. Poster presented at Smartmat-'08 & IWOFM-2nd, Chiangmai, Thailand.
3. Tassanapayak, R., Magaraphan, R., and Manuspiya, H. (2008, June 15-19) Functionalization of Porous Clay Heterostructure for Heavy Metals Removal. Poster presented at PPS-24 Polymer Processing Society, Salerno, Italy.