Electronic Supplementary Information

Enhanced Adsorption of Perfluoro Alkyl Substances for In situ Remediation

Yousof H. Aly[1,2], Daniel P. McInnis[2], Samuel M. Lombardo[3], William A. Arnold[1,3], Kurt D. Pennell[4], James Hatton[5], Matt F. Simcik[1,2]

[1]Water Resources Sciences Program, University of Minnesota, 1985 Buford Ave., St. Paul, MN 55108

[2]School of Public Health Division of Environmental Health Sciences, University of Minnesota, 420 Delaware St., Minneapolis, MN 55455

[3]Department of Civil, Environmental and Geo-Engineering, University of Minnesota, 500 Pilsbury Dr. SE, Minneapolis, MN 55455

[4]Department of Environmental Engineering, Brown University, Providence, RI 02912

Table S.1 Soil testing results:

Sample	Cation Exchange Capacity summation method (meq/100g)	Cation Exchange Capacity direct method (meq/100g)	$CaCO_3$ Equivalent (%)	NO_3-N (ppm)	NH_4-N (ppm)	TOC* (%C)	Inorganic Carbon** (%C)
1	26.31	16.35	18.71	1.19	1.55	1.55	0.72
2	26.59	17.29	18.09	1.73	3.90	1.44	0.83
3	27.81	17.25	18.08	1.13	2.79	1.34	0.93

Sample	Ca (ppm)	K (ppm)	Mg (ppm)	Na (ppm)	Al (ppm)
1	2834.7	118.92	1220.6	415.41	1.30
2	2876.0	118.67	1227.9	416.30	1.70
3	2945.4	197.32	1312.0	413.60	1.22

*** Determined by combustion analysis of subsample fumigated with HCl to remove carbonates**
**** Determined by difference between combustion analysis results for HCl-fumigated and nonfumigated subsamples**

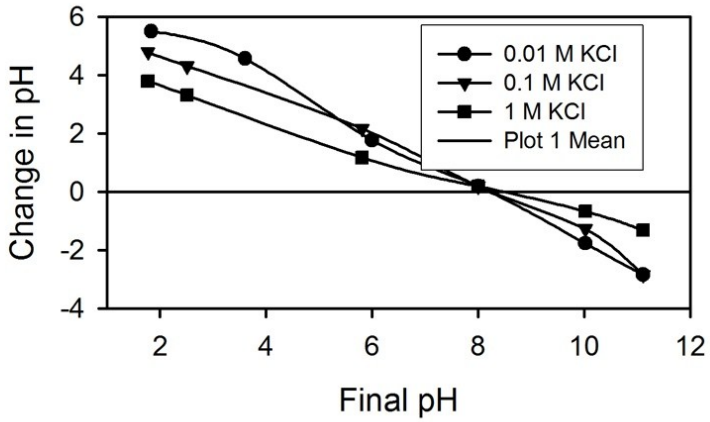
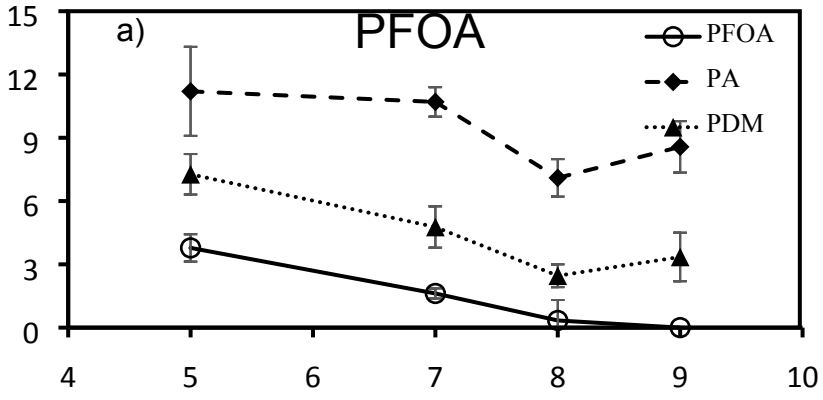


Figure S.1 PZC determination of test soil. Initial pH's were set at 2, 4, 6, 8, and 10. After equilibration for 24 hours, final pH was plotted on the x-axis vs. change in pH on the y-axis. The point of zero charge was selected at the point where change in pH = 0. Error bars representing one standard deviation are smaller than symbols.



K_D (L/ Kg)

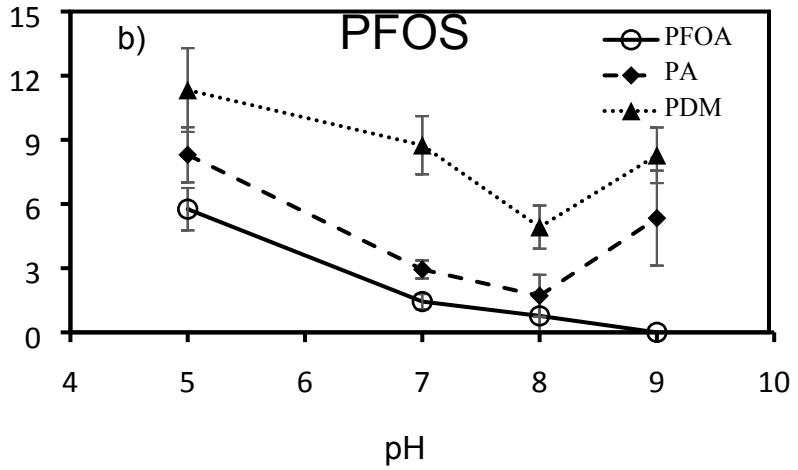


Figure S.2 Replication of PFOA (a) and PFOS (b) batch tests at differing pH values. Open circles represent the control condition, closed diamonds represent the addition of POLYAMINE and closed triangles represent the addition of polyDADMAC. Error bars represent one standard deviation.

Table S.2 P-values from statistical comparisons of batch tests using a t-test (α=0.05). Comparisons with results of α>0.05 are in bold text and not significantly different comparisons.

PFAS	control-polyDADMAC	control-PA	PA-polyDADMAC
PFBS	0.00127	0.00324	**0.598**
PFHxS	3.14×10^{-5}	0.00308	**0.355**
PFOS	0.000395	0.0204	0.00220
PFHpA	0.00192	0.0480	**0.156**

PFOA	0.000624	1.77×10^{-7}	0.00442
PFNA	0.00305	0.000854	0.000329

Figure S.3. Effluent breakthrough curves obtained for PolyDADMAC and polyamine in soil column experiments.

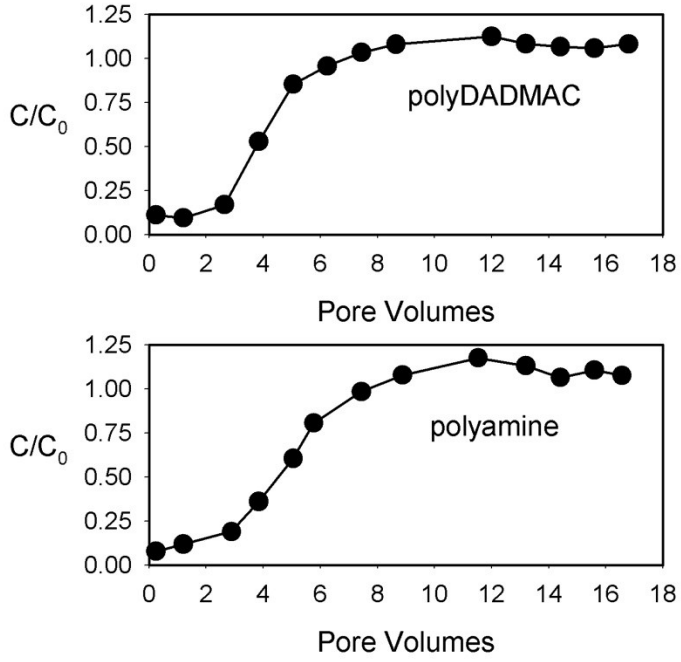


Table S.3 Solid-water distribution coefficients (K_D) of PFAS from column tests on untreated test soil (control) and test soil pretreated with polyDADMAC or polyamine. K_D values normalized to f_{oc} of soil in each batch (K_{oc}) are listed below corresponding K_D values.

K_D/K_{OC} (L/Kg) ± 95% CI	**PFBS**	**PFHxS**	**PFOS**	**PFHpA**	**PFOA**	**PFNA**
Control						
K_D	0.21± 0.02	0.89 ± 0.19	1.23 ± 0.22	0.14 ± 0.01	0.55 ± 0.04	0.75 ± 0.08
K_{OC}	13.9 ± 1.4	59.5± 12.6	82.0± 14.9	9.0± 0.9	36.4± 3.0	50.1± 3.9
Polyamine						
K_D	2.94 ± 0.19	3.29± 0.33	4.70 ± 0.37	1.28 ± 0.22	2.56 ± 0.25	2.56 ± 0.16
K_{OC}	127.3± 8.4	142.5± 12.4	203.3± 16.0	55.4± 9.9	110.9± 11.1	119.8± 6.8
polyDADMAC						
K_D	3.28 ± 0.23	3.81 ± 0.48	8.03 ± 0.80	1.47 ± 0.15	3.18 ± 0.42	3.59 ± 0.46
K_{OC}	149.3± 10.8	173.1± 22.7	365.1± 37.9	66.8± 6.9	144.5± 19.7	163.1± 21.6

PV’s indicate the number of pore volumes required for breakthrough as fitted by the LINEST model.