

A Preliminary Study of the Effectiveness of Nanoscale Iron ("NSI") in Reducing PCBs in Soil

PCB Scrap Yard Fill Source: Five gallon plastic pail containing a composite sample from a soil stockpile generated during a 2000 TSCA PCB cleanup at a scrap yard in Lincoln, Nebraska; soil was treated with Maectite to stabilize leachable lead in the soil prior to excavation; pre-excitation PCB concentrations ranged from 51.7 mg/kg to 1070 mg/kg; also present were elevated concentrations of arsenic, cadmium, chromium, and lead.

1) 11/23/2003 1600: PCB soil from the 5-gallon plastic pail was thoroughly composited and 4.5 kg was added each to two pails labeled A and B; 4 oz composite samples were collected from each pail and labeled "Pre-A" and "Pre-B" and analyzed for PCBs, pH and biphenyl.

PRE-TREATMENT RESULTS

Sample ID	Sample Date/Time	Extraction Date	Mass of Soil (kg)	% Solids	pH	Biphenyl (mg/kg)	Mass of Biphenyls (mg)		Detected PCB	PCBs (mg/kg)	Mass of PCBs (mg)	
Pre-A	11/23/04	11/25/03	4.5	81.39	7.39	1.33	5.985		Aroclor 1254	43.3	195	
Pre-B	11/23/04	11/25/03	4.5	80.83	7.49	2.53	11.385		Aroclor 1254	46.3	208	

2) 1/7/2004 1030: Approximately 3 pounds of NSI solution (0.5 pound Fe + 2.5 pound water) was added to each 4.5 kg soil sample; both samples were thoroughly mixed; Sample B was agitated approximately every eight hours; no additional agitation of Sample A was performed. NOTE: Addition of supplied quantities from manufacturer resulted in an overly saturated, "soupy" sample

3) 1/8/2004 1100: Composite samples were collected from Sample A and Sample B and transported immediately to the laboratory for extraction

Sample Observations: Both samples were highly saturated, dark brown to black, with a slight petroleum odor; a small amount of gas escaped from the samples upon removal of the lid and gas bubbles were present on the surfaces; Sample B was warmer than Sample A; a black, highly turbid liquid phase was present on both samples

POST-TREATMENT (24 HOURS)

Sample ID	Sample Date/Time	Extraction Date	Mass of Soil + Fe (kg)*	% Solids	pH	Biphenyl (mg/kg)	Mass of Biphenyls (mg)	% Biphenyl Change	Detected PCB	PCBs (mg/kg)	Mass of PCBs (mg)	% PCB Change
Post-A24	1/8/04 1100	1/8/04	4.735	70.6	8.08	0.959	4.540865	-24%	Aroclor 1254	25.1	119	-39%
Post-B24	1/8/04 1100	1/8/04	4.735	72.12	8.07	0.8	3.788	-67%	Aroclor 1254	25.6	121	-42%

* = Since PCBs reported on a dry mass basis, water mass from NSI solution was not incorporated

NOTE: A sample of the liquid phase also was collected from Sample A and Sample B and analyzed for PCBs; Sample Post-A24 (water) had a PCB concentration of 0.698 mg/L at a pH of 7.83 and Sample Post-B24 (water) had a PCB concentration of 12 mg/L at a pH of 7.60; likely a result of agitation, Sample B's liquid phase was more turbid and not as pronounced as Sample A; these water samples were not filtered and it is likely that these concentrations did not represent a dissolved constituent (Aroclor 1254 solubility is 1.2E-2 mg/l), but rather a suspended particulate constituent; based on this, no adjustments to concentrations were made.

4) 1/15/04 1600: Composite sample was collected from Sample A and transported to the laboratory

POST-TREATMENT (13 DAYS)

Sample ID	Sample Date/Time	Extraction Date	Mass of Soil + Fe (kg)	% Solids	pH	Biphenyl (mg/kg)	Mass of Biphenyls (mg)	% Biphenyl Change	Detected PCB	PCBs (mg/kg)	Mass of PCBs (mg)	% PCB Change
Post-A7D	01/15/04 1600	1/20/04	4.735	65.72	NA	NA	--	--	Aroclor 1254	12.7	60	-69%

POST-TREATMENT (2-Months)

Sample ID	Sample Date/Time	Extraction Date	Mass of Soil + Fe (kg)	% Solids	pH	Biphenyl (mg/kg)	Mass of Biphenyls (mg)	% Biphenyl Change	Detected PCB	PCBs (mg/kg)	Mass of PCBs (mg)	% PCB Change
Post-A2M	3/8/04 1000	3/8/04	4.735		NA	NA	--	--	Aroclor 1254	3.16	15	-92%

KEY

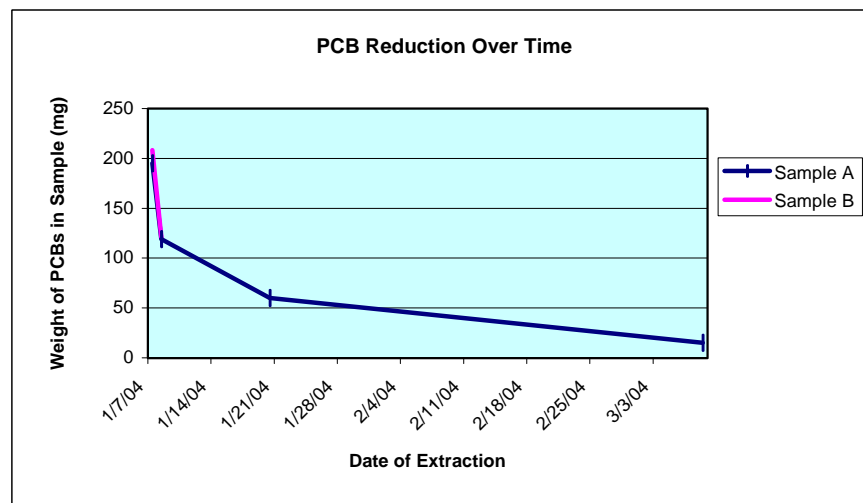
NSI = nanoscale iron product
 PCBs= Polychlorinated Biphenyls
 NA = Not Analyzed

NOTES

Results reported on a dry mass basis
 Analytical methods used are reported on the laboratory reports

Conclusions

- A) pH increases with addition of NSI solution
 B) Although it was suspected that biphenyl concentrations would increase as PCB concentrations decreased, analytical results showed a reduction in biphenyls.
 C) More frequent agitation showed little affect on the rate of PCB reduction
 D) A reduction of PCBs was shown to occur with the introduction of the NSI solution. The reduction rate appears exponential over time:



- E) Use of NSI may be an effective solution to treating soil that is to remain in place to allow time for the reduction to occur.
 F) For short-term effectiveness, a catalyst or temperature increase may be necessary in order to accelerate the dechlorination process.