A.1 Technology Name

Polymeric Sampling Devices and Semi-Permeable Membrane Device

A.1.1 Source

Cho, Yeo-Myoung, David Werner, YongJu Choi, and Richard G. Luthy. 2012. Long-Term Monitoring and Modeling of the Mass Transfer of Polychlorinated Biphenyls in Sediment Following Pilot-Scale in-Situ Amendment with Activated Carbon. Journal of Contaminant Hydrology, Sorption and Transport Processes Affecting the Fate of Environmental Pollutants in the Subsurface, 129–130: 25–37. https://doi.org/10.1016/j.jconhyd.2011.09.009.

A.1.2 Summary

Media:	Porewater
Study Type:	In-situ
Technology:	Semi-Permeable Membrane Device (SPMD) and polyethylene (PE)
Peer Reviewed:	Yes
Publication Date:	March 2012

A.1.3 Site Description

The study reports the results of five years of post-treatment monitoring following in-situ activated carbon (AC) placement for stabilization of PCBs at an inter-tidal mudflat adjacent to Hunters Point Shipyard, San Francisco Bay, CA, USA:

- The treatment involved in-situ blending of approximately 3% dry weight of AC into a 30 cm layer of sediment. This process was conducted at Plot A in August 2004 and at Plot D in January 2006.
- The long-term effectiveness of AC amendment was evaluated by deploying in-situ SPMD samplers (28-day) within the top 10 cm of sediment at Plot A, at intervals of 1 month, 7 months and 5 years following AC application.
- A study of the local AC dosage response was carried out at Plot A, 5 years post-treatment, using in-situ PE samplers (28-day) deployed at depths of 5-10 cm, 10-15 cm, and 15-20 cm below the sediment surface.
- Ex-situ measurements of aqueous PCB concentrations (not by passive sampler) were conducted by mixing water and sediment for 14 days in rotated bottles. These measurements were taken at Plot D at 6 months, 18 months, and 3.5 years after AC application; and at Plot A at 5 years post-application.
- Total organic carbon (TOC) in the sediments was analyzed at both millimeter-scale (approximately 100 mm^3 sediment) and within 5-cm long core segments to determine the AC dosage.
- Porewater velocities were derived using an inverse heat transfer analysis as described in Cho et al., 2010.
- No non-equilibrium corrections were applied to the passive sampler results.

A.1.4 Remedial Phase

Feasibility Study (Field Demonstration)

A.1.5 Outcome

AC stability: After five years, AC levels in sediment cores remained consistent, indicating stability under field conditions.

PCB reduction in porewater: PCB uptakes in passive samplers decreased by up to 73% with a 3.7% dry weight AC dose after five years.

Effectiveness of AC treatment over time: The reduction of in-situ SPMD porewater PCB concentrations increased with AC-sediment contact time, suggesting slower mass transfer of PCBs to the AC under field conditions and the thermodynamic sorption equilibrium wasn't fully reached within the monitoring period.

Ex-situ vs. in-situ observations: Ex-situ aqueous PCB concentrations showed greater reductions than in-situ concentrations, suggesting continuous ex-situ mixing enhanced the mass transfer.

Effectiveness of AC treatment was reduced by NOM fouling, slower porewater velocities (*i.e.,* slower PCB transfer from sediment to AC), and heterogeneous AC distribution. For example, to obtain an average 80% of reduction of PCB 101 in sediment porewater, it took only one year with a homogeneous AC distribution but 6 years with poorly distributed AC.

A.1.6 References

Cho, Y.-M., Werner, D., Moffett, K.B., Luthy, R.G., 2010. Assessment of advective porewater movement affecting mass transfer of hydrophobic organic contaminants in marine intertidal sediment. Environmental Science & Technology 44 (15), 5842–5848.