A.1 Technology Name

Semipermeable Membrane Device (SPMD)

A.1.1 Source

Booij, Kees, Foppe Smedes, Evaline M. Van Weerlee, and Pieter J. C. Honkoop. 2006. Environmental Monitoring of Hydrophobic Organic Contaminants: The Case of Mussels versus Semipermeable Membrane Devices. Environmental Science & Technology 40(12), 3893–3900. https://doi.org/10.1021/es052492r.

A.1.2 Summary

Media:	Water column
Study Type:	In-situ ->ComparisonWa
Technology:	SPMD (in comparison of mussel)
Peer Reviewed:	Yes
Publication Date:	June 1, 2006

A.1.3 Site Description

- The purpose of this study was to quantitatively understand SPMD/mussel concentration ratios and develop a model for linking bivalve data to SPMD data.
- The study uses concentrations of hydrophobic chemicals in mussels and SPMDs from nine studies published over the past decade, amended with new data obtained in the Scheldt−North Sea area.
- New data in the Scheldt−North Sea area are from SPMDs and mussels deployed for 38 to 43 days at five sites during 25 January to 18 March 1999. SPMD comprises of polyethylene lay-flat tubing (29 cm long, 2.54 cm wide, and 70 μm thick), containing 21% (w/w) triolein spiked with seven performance reference compounds (PRCs).
- Model development:

  Concentrations in mussels (ng/g dry-weight basis) were derived from bioaccumulation factors (BAFs, wet-weight basis) and elimination rate constants (k_2), and dry-weight fraction of mussels (f_{dw}) as:

$$C_m = \frac{C_w BAF(1 - \exp[-k_2 t])}{f_{dw}}$$

  Concentrations in SPMDs (ng/g on a whole sampler weight basis) were derived from SPMD-water partition coefficients (K_{sw}), the first-order elimination rate constant (k_e), and density of SPMD (ρ_s) as:

$$C_s = \frac{C_w K_{SW}(1 - \exp[-k_e t])}{\rho_s}$$

  Parameter estimates for k_2 (d^{-1}), BAF, K_{sw}, and k_e (d^{-1}) were derived as a function of K_{ow} based on literature data.

A.1.4 Remedial Phase

Not applicable. Sampler evaluation.

A.1.5 Outcome

SPMD/mussel concentration ratios were plotted against log Kow values. Results show that the ratio is fairly constant for log Kow values between 4.5 and 5.5, but decreases as log Kow values increases from 5.5 to 7. The model could successfully describe the concentration ratios reported in seven studies. Differences in concentration ratios among these studies were related to the variations in mussel BAFs and the water sampling rates of SPMDs.

The authors suggest that SPMDs will generally yield more reliable estimates of exposure concentrations than mussels. This is because in situ BAF values in mussels are difficult to estimate, whereas the in situ exchange kinetics of SPMDs can be quantified by measuring the dissipation rates of PRCs. Furthermore, K_{sw} values for SPMD are less variable than BAFs in mussels. Finally, using SPMDs avoids the need for using different bivalve species across large geographical areas, thereby enhancing data comparability.