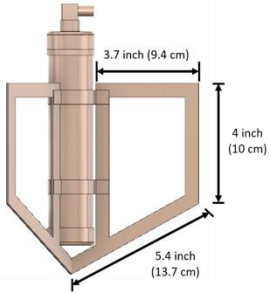
Testing of Prototypes of Actively Shaken In-Situ Passive Sampler Platform for Polychlorinated Biphenyls



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Chemical Biochemical and Environmental Engineering

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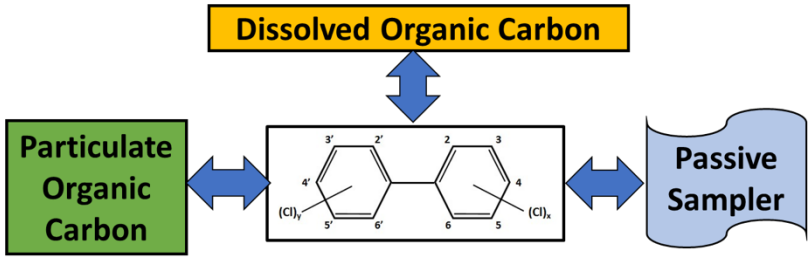
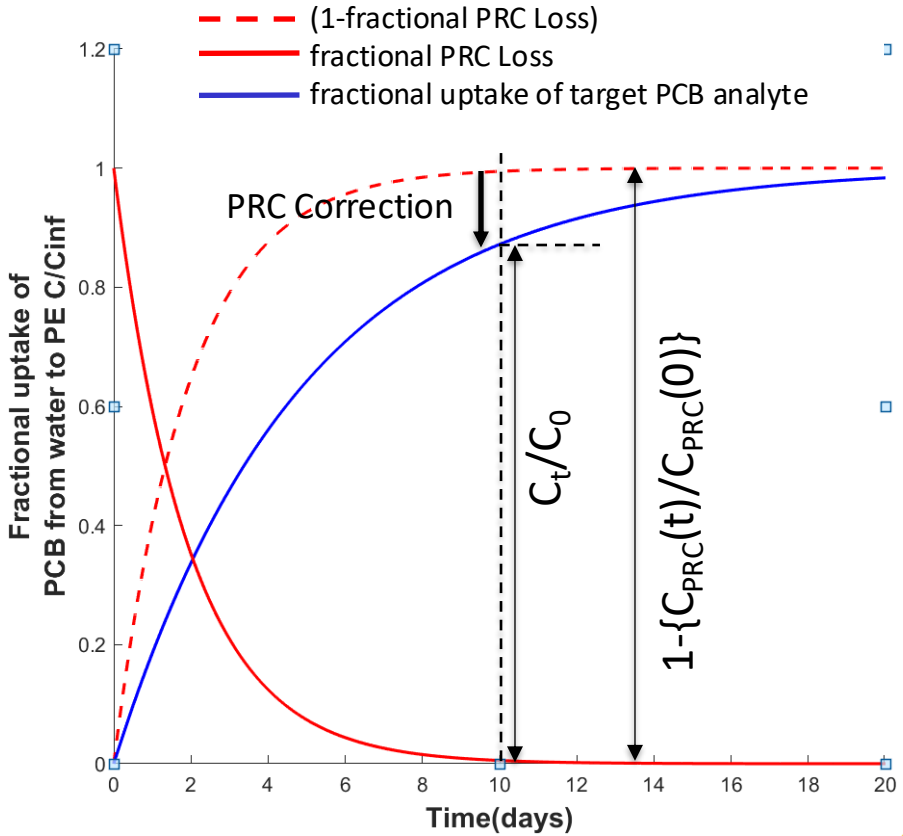
Introduction to Passive Sampling



PASSIVE SAMPLING:

- Provides freely dissolved concentration : pollutant bioavailability
- Very low detection limits (ng/L to pg/L)
- Avoids need for collecting and extracting large volumes of water to meet instrument detection limits

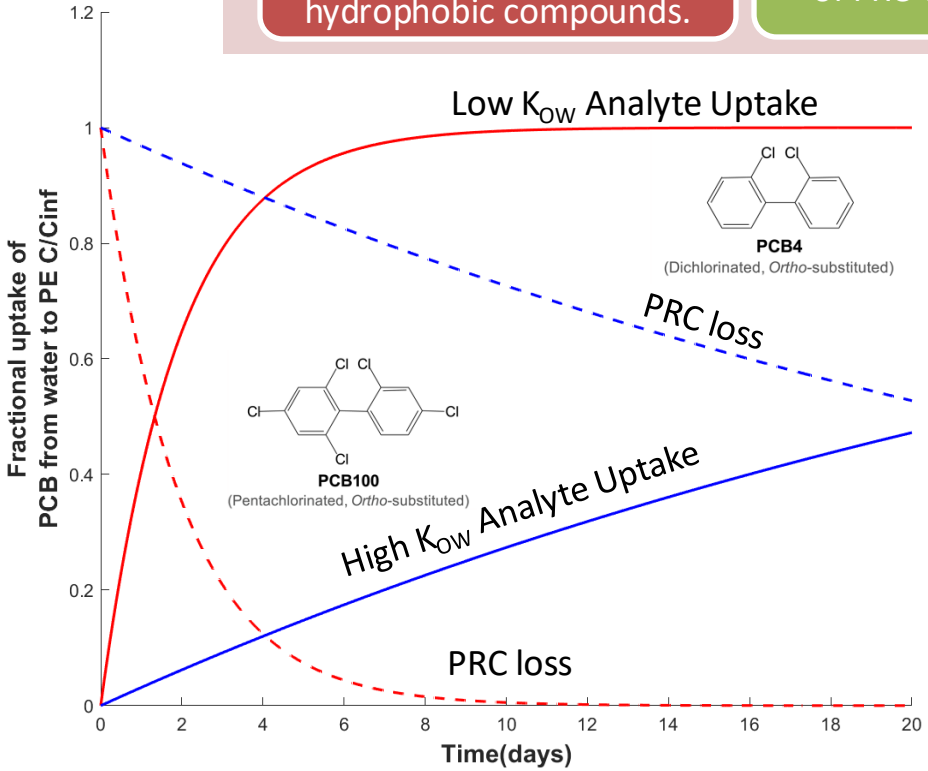


Research Motivation

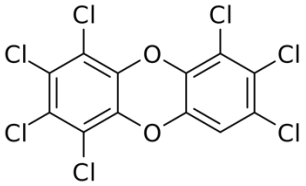
Slow mass transfer in sediment porewater of more hydrophobic compounds.

Larger errors in calculation of PRC Correction term.

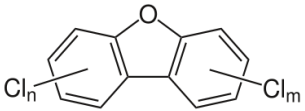
Inaccurate C_{free} measurement



Dioxins

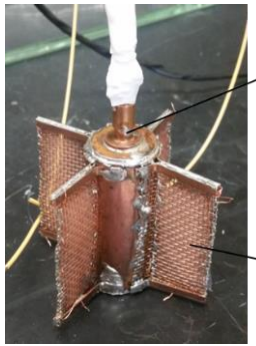


Furans



Develop passive sampling platform that introduces periodic vibration for faster uptake of more hydrophobic compounds (like higher homolog PCBs/dioxins/furans) by disrupting Water Boundary Layer.

Prototypes: P1_14G_AN02F (VibraSP3™)



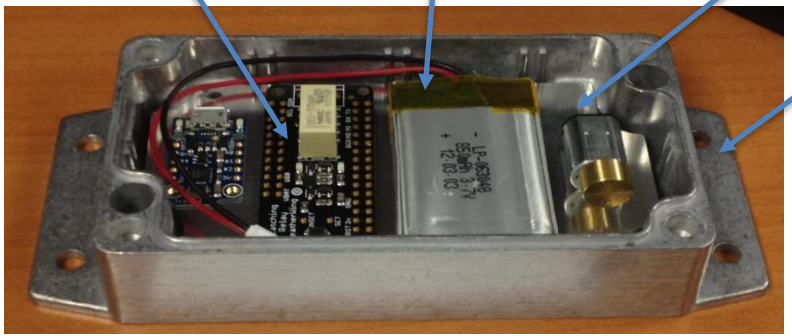
25mm vibration motor from Precision Microdrive

20 mg polyethylene

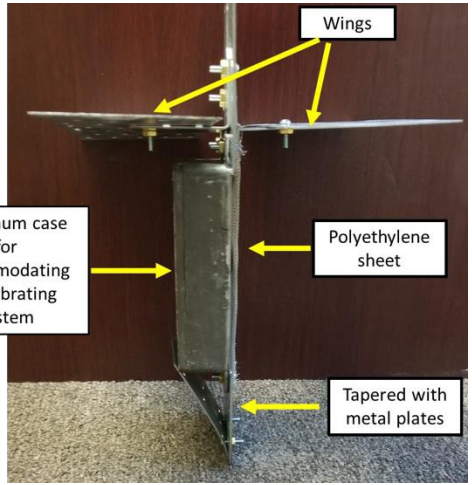
Mini microcontroller

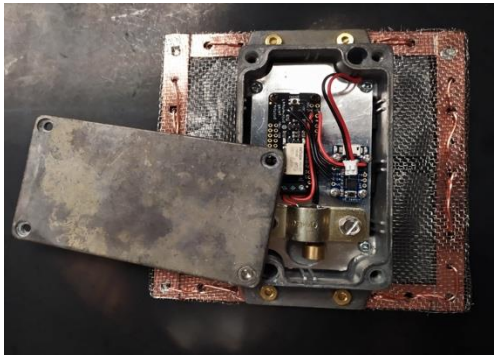
3.7 V lithium 2500mAh Battery

3 V (14.3 G) Vibration motor from Precision Microdrives



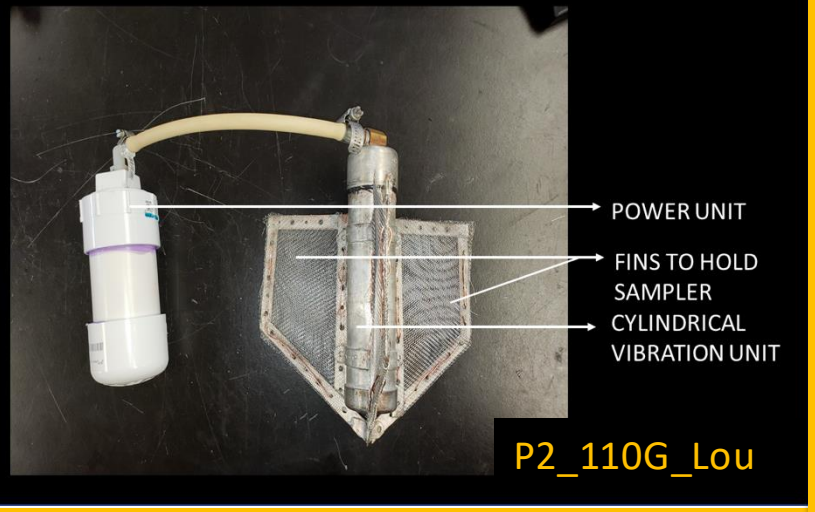
Aluminum case

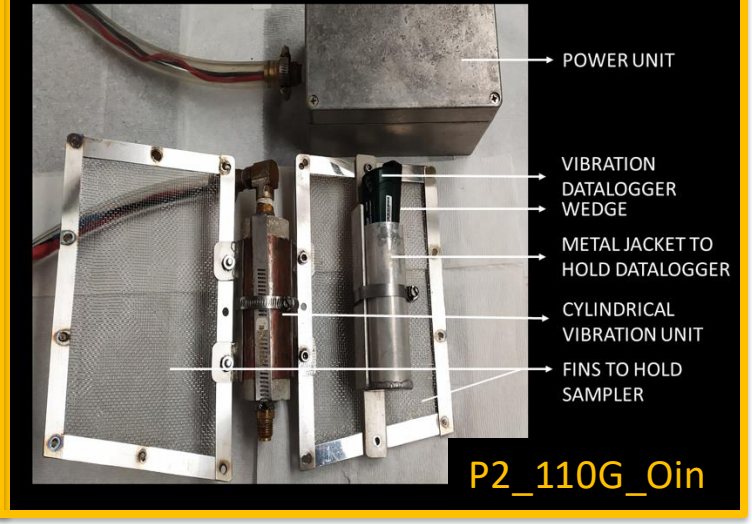




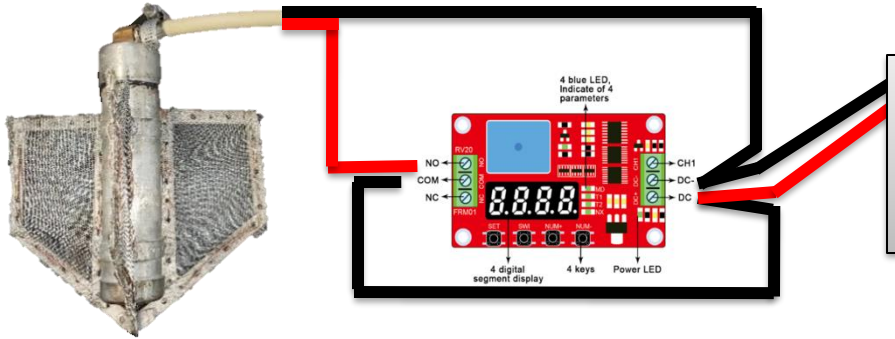
Geosyntec consultants

Prototypes: P2_110G_Lou/Oin





Rated Operating Voltage	12 V
Typical Norm. Amplitude	110 G



12V, 2500mAh Lithium Polymer Battery.

Methods

Field Test:

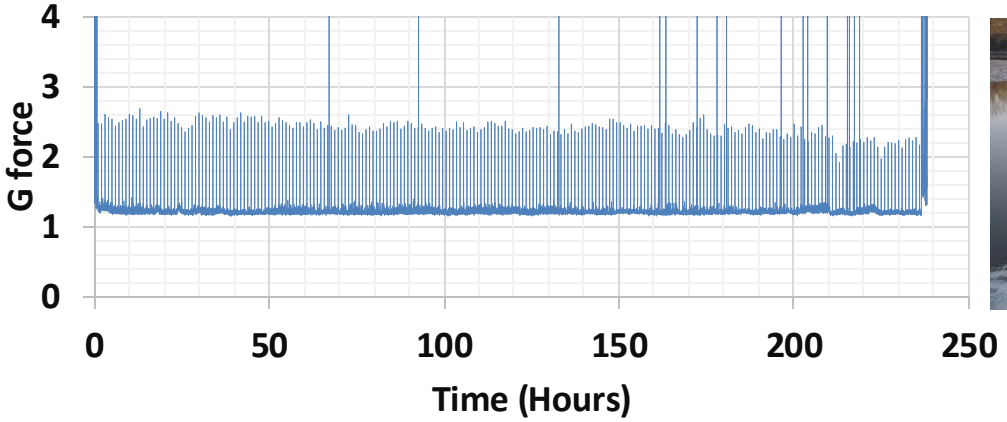
Kingman Lake in Washington D.C.

10-day long deployment [10-20 Dec 2019]

In-Lab Experiment:

- Sediments from several sites homogenized with water.
- 2L Beaker: Static Samplers
- 2L Glass jar with lid: Fully-Mixed slurry on roller
- PE sheets impregnated with C13 Performance Reference Compounds (PRCs)
- Vibration Frequency: 5s pulse, 1 hour pause.

Field Testing & problems we ran into…



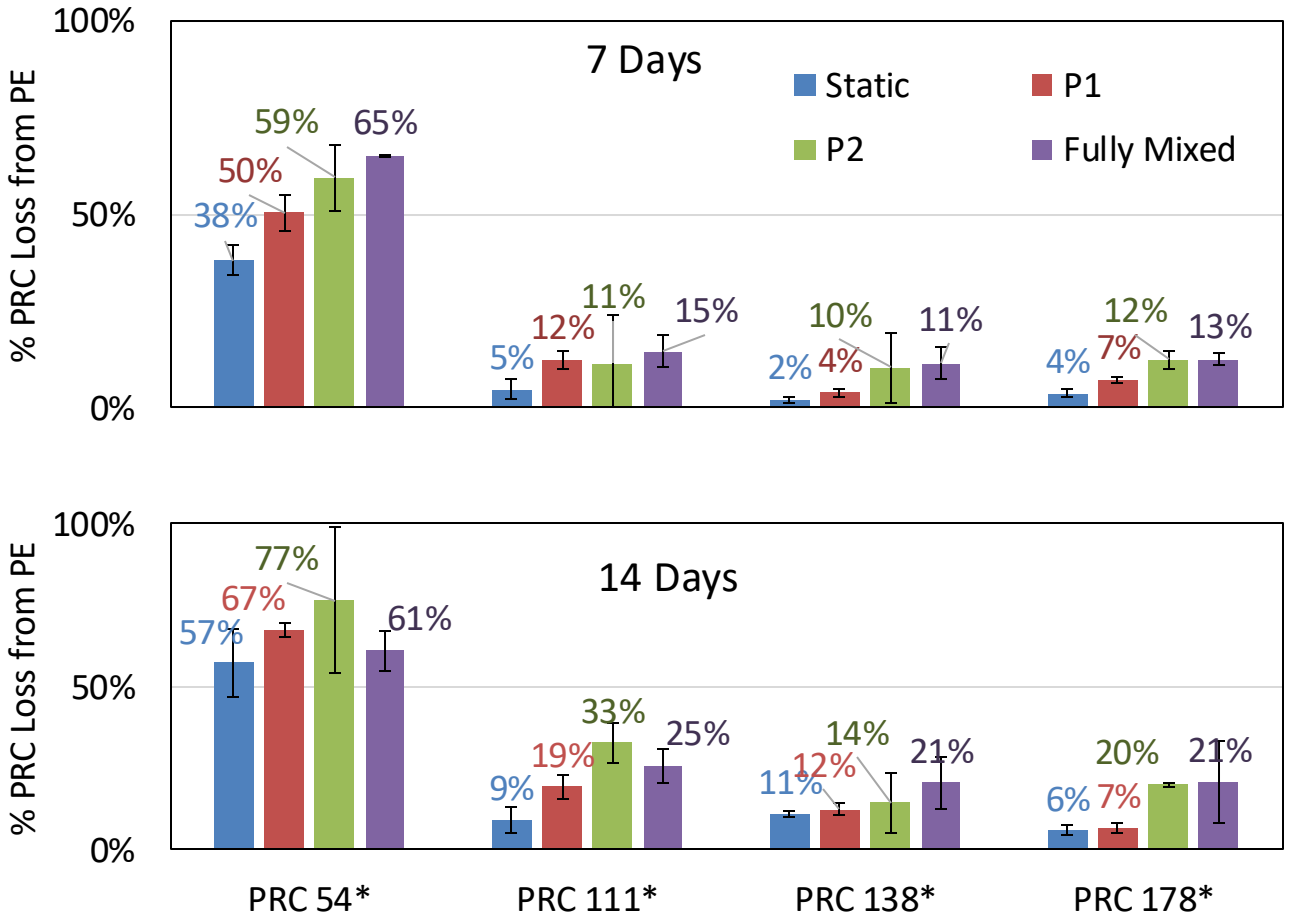
P2_110G_Oin vibrated with an amplitude of ~2.5G while inside 3” of sediment throughout the deployment time of 10days until it was taken on the day of retrieval.

Normal (un-labelled , C12) PRCs

↓

C13 PRCs

In-Lab Testing



PRC 54* - tetra

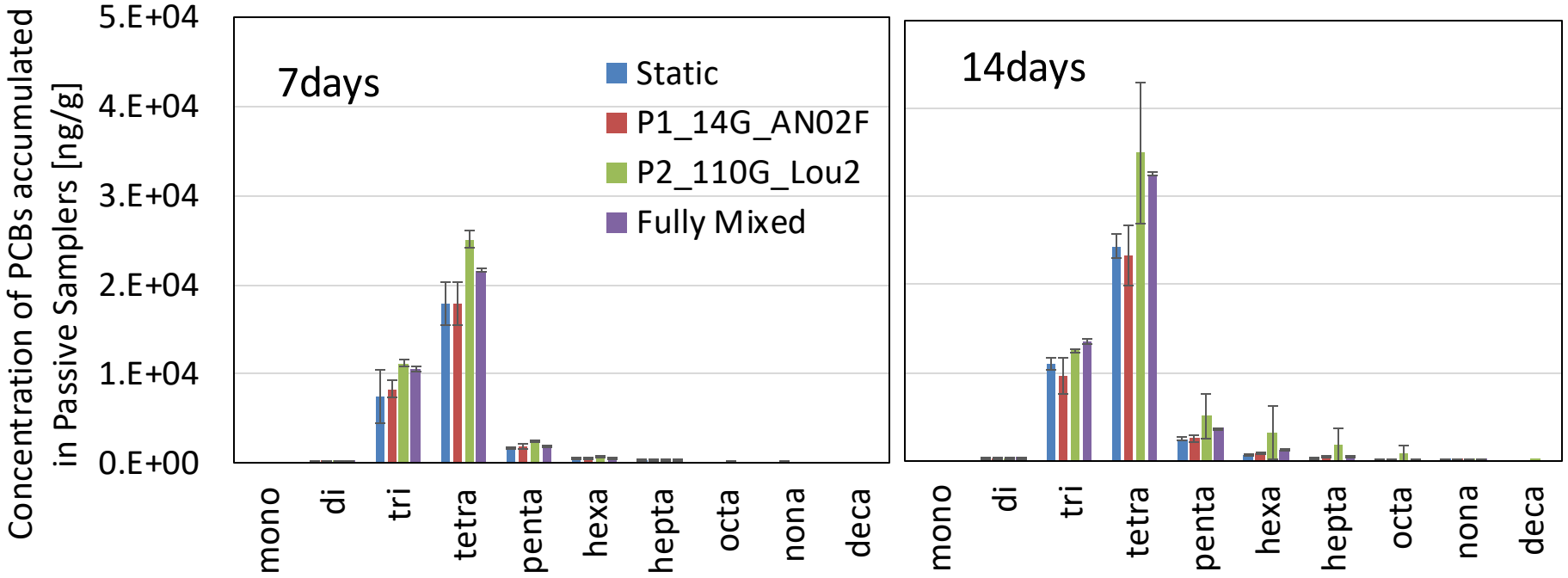
PRC 111* -penta

PRC 138* -hexa

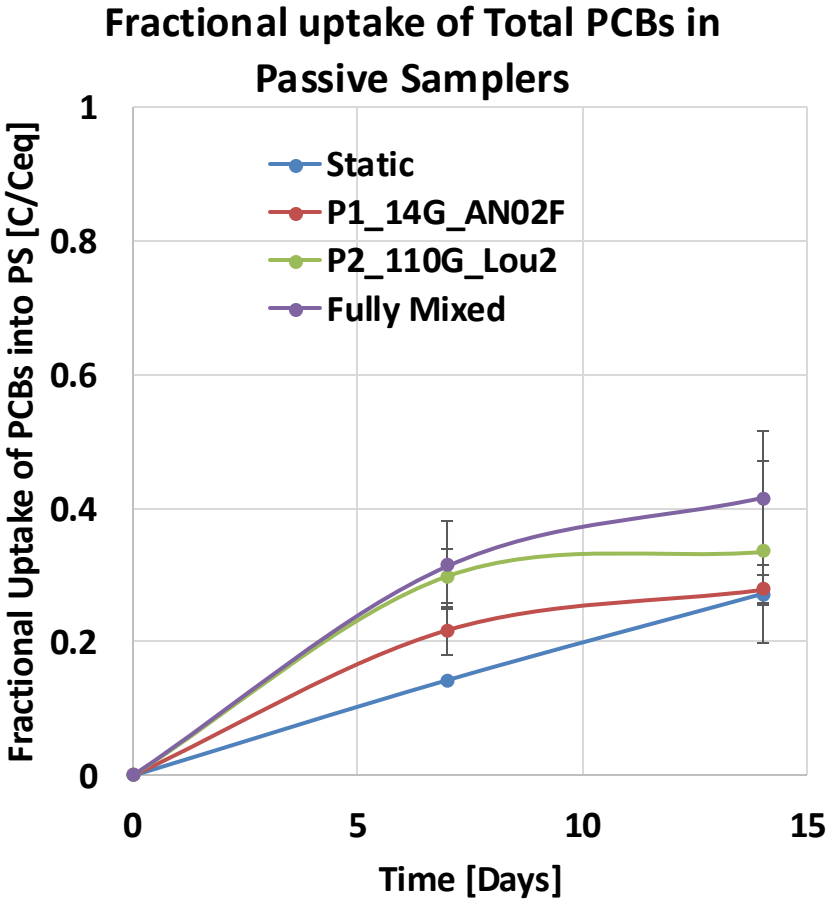
PRC 178* -hepta

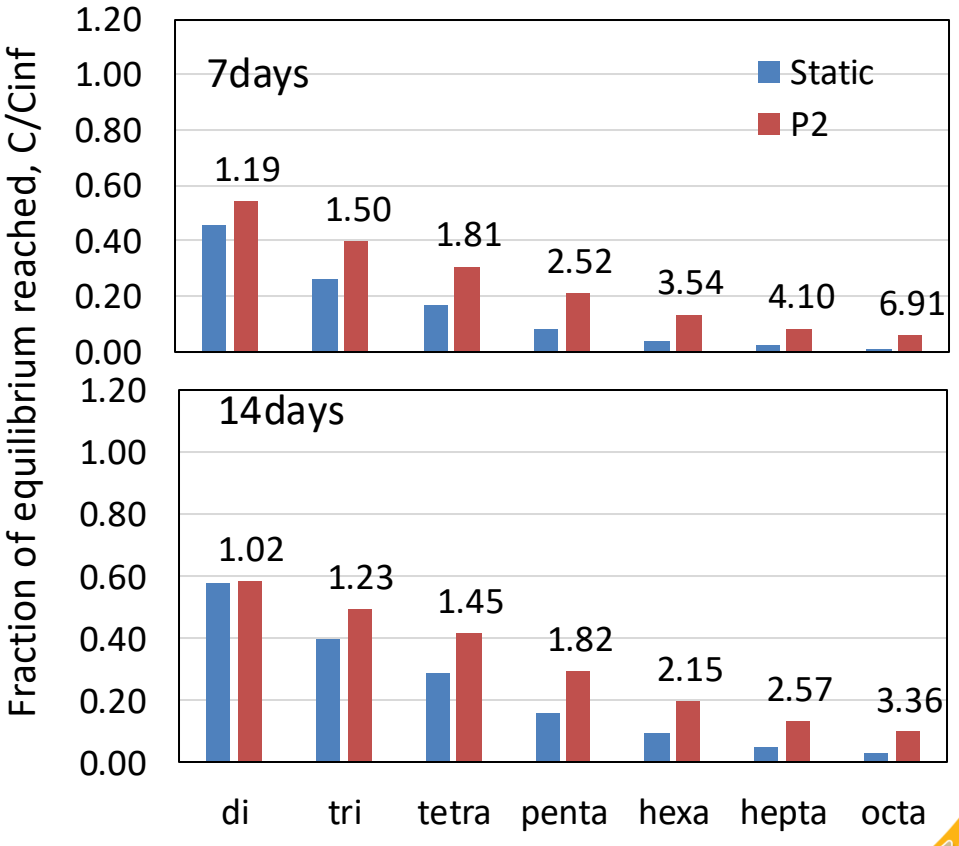
- Higher rate of loss of the lower homolog PRCs
- Loss of PRC in static slower than in the vibrating prototypes (gap reduces with more hydrophobic PRC)

Concentration of PCBs accumulated in Passive Samplers, Cps



In-Lab Testing





Conclusions

- Overall, introducing periodic vibration to the passive sampling platform improved mass transfer by introducing turbulence artificially.
- With constant vibration frequency for both prototypes, a stronger vibration helped in approaching equilibrium faster. Also, the larger prototypes can accommodate more mass of PE.
- Big improvement in the rate of approaching equilibrium for higher homolog groups (hexa to octa) when vibration is introduced.
- A more frequent but short-lived vibration might improve the rate of equilibrium even further.
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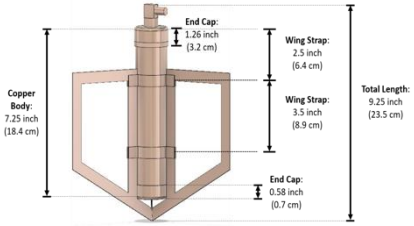
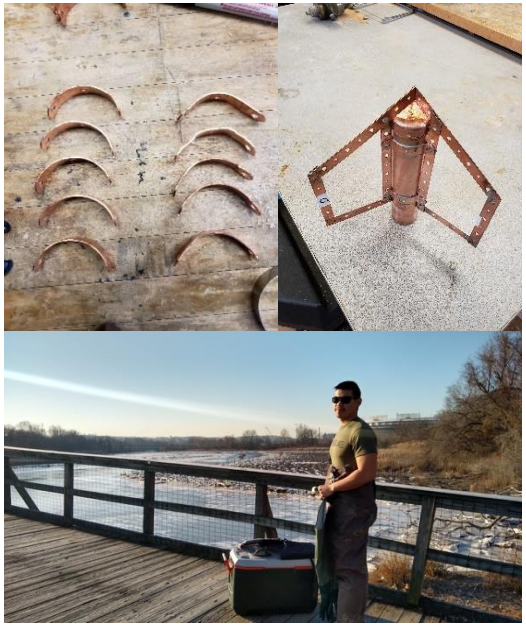
- Increase the effectiveness of the vibration by changing how far the fins extend.





Thank You

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