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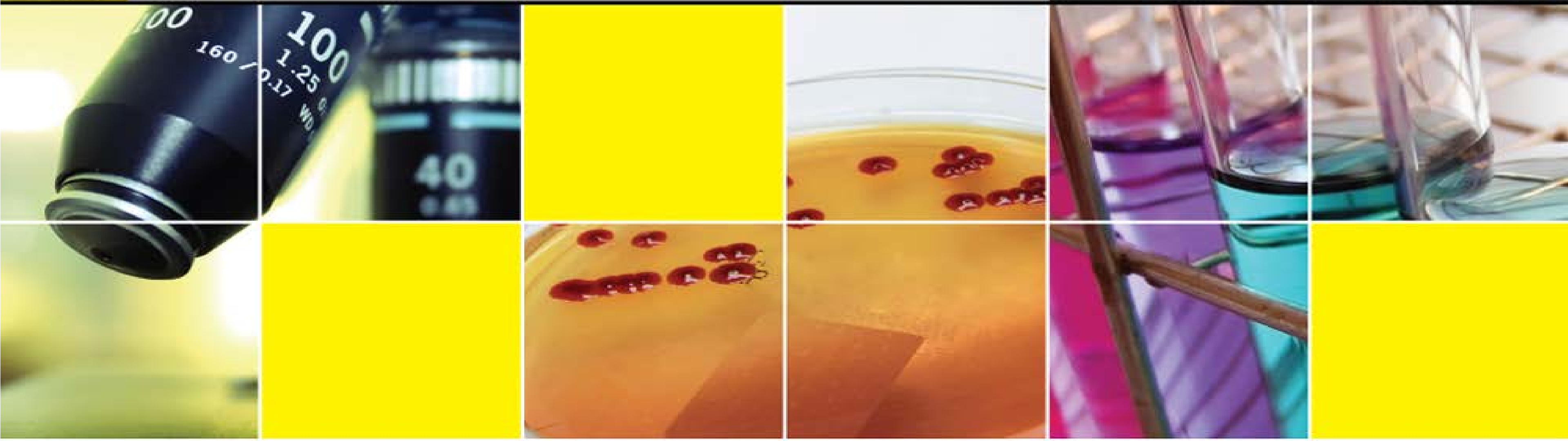


Impact of Peristaltic Pump Tubing type on Organic Analyte Concentrations

Robert Hamel, PhD

Background

Low flow rate purging and sampling

<u>Advantages</u>

- **Samples representative of the 'mobile' load of contaminants present.**
- **Minimal drawdown**
- **Reduced need and/or time for filtration**
- **Less purging volume (reduced waste disposal cost sampling time)**
- **Reduction in sampling variability (ex: turbidity)**

Background

Low flow rate purging and sampling

Disadvantages

- **Higher initial capital costs**
- **Greater set-up time**
- **More equipment to transport to and from the field**
- **More training required**
- **Concern that new data will indicate a "change in conditions"**

Background

Low-Flow Sampling Devices:

- **Peristaltic pumps**
- **Bladder pumps**
- **Electrical submersible pumps**
- **Gas-driven pumps**

Note: bailers, and other "grab" type samplers are not suited for low-flow sampling. Also, lift foot-valve samplers may cause too much disturbance

Experimental Design

Objectives:

To determine whether the use of elastic tubing in a peristaltic pump results in a negative bias in the concentration of Organic Analytes for Ground Water samples collected using a low-flow sampling protocol.

To evaluate the impact of the sampling method on analyte recovery.

To study the impact of Ground Water PAH concentrations in the presence of Sediment/Particulate in ground water samples. (Data Review)

Experimental Design

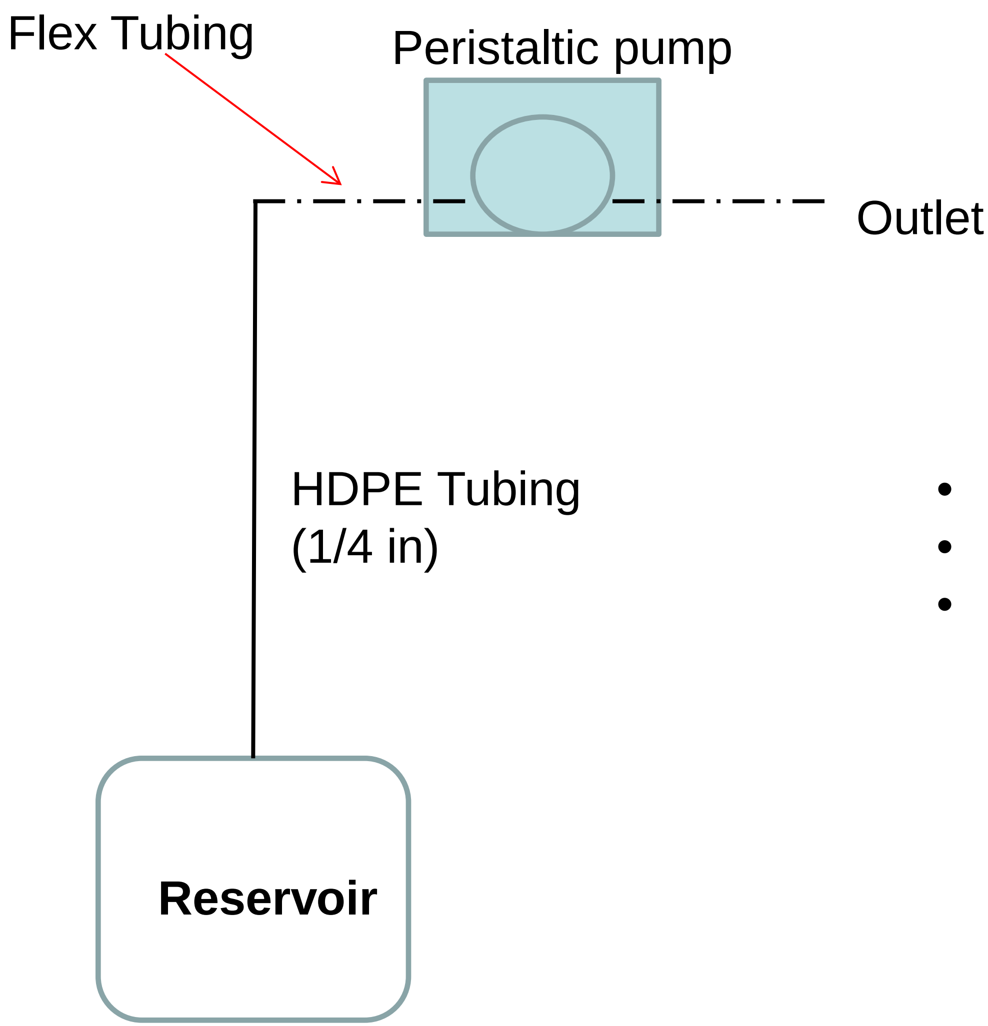
Experimental Variables:

- Type of elastic tubing (Silicone, Viton)
- Analyte Hydrophobicity
- Flow rates (100 mL/min, 300 mL/min, 500 mL/min)

Analytes:

- **Polycyclic Aromatic Hydrocarbons (PAH).**

Experimental Design



- HDPE (7.62 m)
- Flex Tubing (30 cm)
- Reservoir (20L, Polyethylene)

Average Percent Recoveries of PAHs From Polyethylene Reservoir (Grab Sample)

Experimental Controls	Polyethylene Reservoir (MilliQ Water) Initial	Polyethylene Reservoir (MilliQ Water) Final	Spiked Reservoir Initial	Spiked Reservoir Final
PAH				
Naphthalene	ND	ND	105%	98%
Acenaphthylene	ND	ND	98%	84%
Acenaphthene	ND	ND	98%	77%
Fluorene	ND	ND	98%	84%
Phenanthrene	ND	ND	105%	84%
Anthracene	ND	ND	84%	83%
Fluoranthene	ND	ND	91%	90%
Pyrene	ND	ND	91%	83%
Benz(a)anthracene	ND	ND	57%	56%
Chrysene	ND	ND	77%	66%
Benzo(b)fluoranthene	ND	ND	55%	47%
Benzo(k)fluoranthene	ND	ND	105%	98%
Benzo(a)pyrene	ND	ND	77%	70%
Indeno(1,2,3-cd)pyrene	ND	ND	70%	70%
Dibenz(a,h)anthracene	ND	ND	37%	38%
Benzo(g,h,i)perylene	ND	ND	58%	58%
2-and 1-methyl Naphthalene	ND	ND	119%	98%

Average Percent Recoveries of PAHs - Low-Flow Sampling

Flex Tubing	Silicone Tubing 100 mL/min	Viton Tubing 100 mL/min
PAH		
Naphthalene	75% ± 8%	82% ± 4%
Acenaphthylene	58% ± 4%	60% ± 2%
Acenaphthene	52% ± 4%	54% ± 3%
Fluorene	51% ± 3%	52% ± 2%
Phenanthrene	49% ± 2%	49% ± 2%
Anthracene	41% ± 2%	41% ± 3%
Fluoranthene	42% ± 2%	42% ± 2%
Pyrene	43% ± 1%	43% ± 1%
Benz(a)anthracene	34% ± 0%	34% ± 2%
Chrysene	44% ± 1%	45% ± 1%
Benzo(b)fluoranthene	32% ± 4%	30% ± 2%
Benzo(k)fluoranthene	67% ± 5%	69% ± 8%
Benzo(a)pyrene	49% ± 1%	49% ± 3%
Indeno(1,2,3-cd)pyrene	61% ± 4%	62% ± 4%
Dibenz(a,h)anthracene	36% ± 12%	41% ± 7%
Benzo(g,h,i)perylene	60% ± 17%	63% ± 13%
2-and 1-methyl Naphthalene	70% ± 6%	72% ± 4%

Average Percent Recoveries of PAHs - Low-Flow Sampling

PAH \ Flow rate	100 mL/min	300 mL/min	500 mL/min
Naphthalene	75% ± 8%	89% ± 4%	94% ± 4%
Acenaphthylene	58% ± 4%	64% ± 5%	84% ± 3%
Acenaphthene	52% ± 4%	59% ± 6%	73% ± 5%
Fluorene	51% ± 3%	57% ± 7%	67% ± 2%
Phenanthrene	49% ± 2%	59% ± 8%	65% ± 3%
Anthracene	41% ± 2%	43% ± 7%	60% ± 2%
Fluoranthene	42% ± 2%	46% ± 8%	61% ± 6%
Pyrene	43% ± 1%	46% ± 8%	56% ± 3%
Benz(a)anthracene	34% ± 0%	35% ± 6%	45% ± 4%
Chrysene	44% ± 1%	46% ± 5%	57% ± 5%
Benzo(b)fluoranthene	32% ± 4%	30% ± 5%	41% ± 5%
Benzo(k)fluoranthene	67% ± 5%	75% ± 8%	84% ± 4%
Benzo(a)pyrene	49% ± 1%	51% ± 2%	52% ± 4%
Indeno(1,2,3-cd)pyrene	61% ± 4%	57% ± 3%	65% ± 4%
Dibenz(a,h)anthracene	36% ± 12%	41% ± 1%	45% ± 4%
Benzo(g,h,i)perylene	60% ± 17%	61% ± 2%	64% ± 3%
2-and 1-methyl Naphthalene	70% ± 6%	86% ± 11%	90% ± 7%

Average Percent Recoveries of PAHs - Low-Flow Sampling

PAH	500 mL/min	Spiked Reservoir Initial	Spiked Reservoir Final
Naphthalene	94% ± 4%	105%	98%
Acenaphthylene	84% ± 3%	98%	84%
Acenaphthene	73% ± 5%	98%	77%
Fluorene	67% ± 2%	98%	84%
Phenanthrene	65% ± 3%	105%	84%
Anthracene	60% ± 2%	84%	83%
Fluoranthene	61% ± 6%	91%	90%
Pyrene	56% ± 3%	91%	83%
Benz(a)anthracene	45% ± 4%	57%	56%
Chrysene	57% ± 5%	77%	66%
Benzo(b)fluoranthene	41% ± 5%	55%	47%
Benzo(k)fluoranthene	84% ± 4%	105%	98%
Benzo(a)pyrene	52% ± 4%	77%	70%
Indeno(1,2,3-cd)pyrene	65% ± 4%	70%	70%
Dibenz(a,h)anthracene	45% ± 4%	37%	38%
Benzo(g,h,i)perylene	64% ± 3%	58%	58%
2-and 1-methyl Naphthalene	90% ± 7%	119%	98%

SORPTION

Interaction of a contaminant with a solid

- **Adsorption:** Interaction with the surface of a solid.
- **Absorption:** Uniform penetration of the solid by a contaminant.
- **Sorption:** Generic term that encompasses both phenomena

Factors Affecting the Interaction of a Contaminant and the Surface of Soil or Aquifer Materials

- **Chemical and physical characteristics of the contaminant**
- **Composition of the surface of the solid**
- **The fluid media**

Sorption and Physical and Chemical Properties of Contaminants

- **Redox Potential**
- **Acid/Base Chemistry**
- **Partition Coefficient (K_{ow})**
- **Polar/Ionic Character**
- **Water Solubility**

Soil Characteristics Affecting Sorption

- Surface Area
- Surface Charge
- Organic Content
- Texture
- Homogeneity
- Permeability or porosity
- Mineralogy

Affect of Sediment on GW PAH Data

PAH	O.Reg. 153/04 Regulatory Limit (ug/L)	Sediment-Flagged Samples	Non-Flagged Samples	Log Kow
Naphthalene	7	6%	0.2%	3.37
Acenaphthene	4.1	2%	0.0%	3.98
Acenaphthylene	1	4%	0.1%	4.07
Fluorene	120	3%	0.0%	4.18
Phenanthrene	0.1	15%	7.7%	4.46
Anthracene	0.1	6%	2.2%	4.5
Pyrene	0.2	6%	2.2%	4.88
Fluoranthene	0.4	4%	0.7%	4.9
Benz(a)anthracene	0.2	6%	0.5%	5.63
Chrysene	0.1	7%	1.4%	5.63
Benzo(b)fluoranthene	0.1	8%	1.4%	6.04
Benzo(a)pyrene	0.01	6%	2.2%	6.06
Indeno(1,2,3-cd)pyrene	0.2	5%	0.2%	6.58
Benzo(g,h,i)perylene	0.2	8%	0.2%	6.78
Benzo(k)fluoranthene	0.1	10%	1.0%	6.84
Dibenz(a,h)anthracene	0.2	0%	0.0%	6.86

1000 randomly selected GW samples flagged for the presence of sediment
1000 randomly selected sediment-free samples

Conclusions

- Silicone vs. Viton tubing use in the peristaltic pump did not show any significant changes in PAH recoveries
- Higher flow rates showed improved PAH recoveries
- HDPE Tubing resulted in bias low PAH recoveries
- Sediment in GW samples resulted in elevated PAH values

1000 randomly selected GW samples flagged for the presence of sediment
1000 randomly selected sediment-free samples

THANK YOU

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