Presentation Outline (30 Slides)

- Wet Foam Elution
- Current InnovaPrep Technologies, Matrix exchange, Final sample volume pre-determination
- Filter Extraction
- Direct Concentration

Disclaimer: InnovaPrep is an enabling automated sample prep technology, not a sampler or detector...
• Sample collection into 2 - 15 mL
• Identifiers accept 5 - 200 µL

From 90% to 99.97% of the sample is not analyzed.
How are we going to analyze all of THAT!? We need the Innovaprep!
InnovaPrep Technologies

Liquid-to-Liquid Concentration & Automated Sample Preparation
(Patents pending)
Wet Foam Elution

- Improved Elution
  - “Expanded Liquid”
  - Increased Viscosity – reduced channeling (Yan et al., 2006)
  - Moves as rigid body with very narrow (<10 µm) lubricating layer (Briceno and Joseph, 2003; Tisne et al., 2004)
- Bursting bubbles
- Quickly Breaks Down into a Liquid
- Maintains Sample Viability in buffer or appropriate matrix

*Patents Pending*
Wet Foam Elution of Electret Filter

Elution ~ 5 seconds

Breakdown of foam ~ 25 seconds
Liquid to Liquid Concentration

- Dead-end hollow fiber membrane filtration
- Automated process
- Wet Foam Elution of captured particles routinely into volumes as small as 40 µL (volumes as low as 4 µL have been demonstrated)
InnovaPrep Process Is:

- Physical Size Separation technology
  - Up to ~1000 : 1 V/V concentration per step
    - Theoretically unlimited initial volume, but the final concentrated sample volume is dependent on mass loading
  - Target particle separation and concentration by size
- Buffer exchange
  - Sample can be delivered in a fluid chosen by user within wide parameters
- Final volumes are settable by user
- “Particles” as small as 1-10 kD
InnovaPrep Process Is Not:

- Not an affinity-based technology; but a “Universal” Sample Prep/Concentrator based on physical properties (size, shape)
  - Some analytical interferents can be removed through exchange from sample fluid to extraction fluid (i.e., soluble bivalent metal ions)
  - Some interferents may be concentrated if they are like the target particles (i.e., some humic acids have properties similar to proteins)
Where is Biodetection Headed?

1. Rapid Methods
Where is Biodetection Headed?

2. Automation
What is Missing?

A link between real world sample sizes and the microliter world that these systems operate in!

“A Macro-to-Micro Interface”

Automated Sample Prep and Delivery
Dry Filter Elution

Portable Electret Air Sampler

Patents pending
Product Testing

Test Parameters

- Electret Filter Flow Rate: 200 Lpm
- Nominal Elution Volume using Hand-held Extractor: 6-7 mL
- Loose weave electret
- 1 μm polystyrene microspheres
- High Collection and extraction efficiency
Direct Concentration

“The Matrix”
Efficiency of Concentrating and Recovery of Particles

- Concentrated Particles Contained in 20 mL of fluid into 250 µL
- Concentration factors ranging from 50x to 120x
- The processing times were ~1 mL/min for the 0.05 µm and 0.025 µm PSMs
- The processing times were ~10 mL/min for the 1.0 and 4.5 µm PSMs
Matrix Testing Results
(100 kD Concentration Cells)
Summary of Recovery Efficiencies (100 kD Concentration Cells)

Recovery Efficiency (%) vs. Polystyrene Microsphere Size (μm)

- Concentrate
- Extract #2
Summary of Concentration Factors
(100 kD Concentration Cells)
Matrix Testing Results
(0.05 µm Concentration Cells)

Recovery Efficiency (%) vs. Condition Number

- **1.0 µm**
- **4.5 µm**

Concentration Factor:
- Concentrate
- Extract #2
- Concentration Factor

![Graph showing recovery efficiency and condition number for 1.0 µm and 4.5 µm concentration factors.](image)
Summary of Recovery Efficiencies
(0.05 μm Concentration Cells)

Recovery Efficiency (%)

Polystyrene Microsphere Size (μm)

Concentrate

Extract #2
Summary of Concentration Factors
(0.05 µm Concentration Cells)

Polystyrene Microsphere Size (µm)

Concentration Factor

1 4.5
Efficiency of Concentrating and Recovery of Particles

- Extensively investigated subsequent to the release of the InnovaPrep HSC-40.
- Used carboxylate (functionally coated biosimulant) polystyrene microspheres.
- Variables Investigated during First Phase of Testing:
  - HSC-40 Units
  - Unit Operator
  - Concentration Cells of the Same Configuration
  - Concentration Cells of Different Pore Size
  - Particle Size
Concentration and Recovery of Carboxylate PSMs

<table>
<thead>
<tr>
<th>Particle Size, µm</th>
<th>Represented Particle</th>
<th>Average Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>Agglomerates of bacteria</td>
<td>97%</td>
</tr>
<tr>
<td>1.0</td>
<td>Single bacteria</td>
<td>90%</td>
</tr>
<tr>
<td>0.05</td>
<td>Viruses</td>
<td>79%</td>
</tr>
<tr>
<td>0.025</td>
<td>DNA, Lower limit-viruses</td>
<td>60%</td>
</tr>
</tbody>
</table>
### Concentration and Recovery of Microorganisms

<table>
<thead>
<tr>
<th>Species</th>
<th>Concentration efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus thuringiensis israeliensis</em> (Bti)</td>
<td>97.1 %</td>
</tr>
<tr>
<td><em>Bacillus atrophaeus</em> (Bg)</td>
<td>95.0%</td>
</tr>
<tr>
<td><em>Escherichia coli</em> (Ec)</td>
<td>103%</td>
</tr>
<tr>
<td>MS-2 bacteriophage</td>
<td>92%</td>
</tr>
<tr>
<td>Bg DNA</td>
<td>60%</td>
</tr>
</tbody>
</table>
Maintains Sample Viability
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