



Hydrosol Concentrator

The Macro to Micro Interface

InnovaPrep® provides hydrosol concentrators (liquid-to-liquid concentrators) for improved detection of biological particles in liquids. Through a patent pending process the InnovaPrep system rapidly concentrates bacteria, viruses, DNA, and other particles and large molecules from large liquid volumes into microliter volumes. This capability provides for improved detection of low levels of articles in liquids in the fields of biodefense, food safety, drinking water, ultrapure water, environmental waters, clinical diagnostics, veterinary diagnostics, and many other fields.

Within the concentrator hollow fiber membrane filter concentration cells are used to capture particles from a liquid sample. When the entire sample has been processed a novel “wet foam elution” process is used to efficiently recover the captured particles into volumes as small as 50 µL.

InnovaPrep is currently offering three configurations of their hydrosol concentrator; the HSC-40, a bench-top research instrument; a fieldable unit housed in a Pelican™ case; and systems designed for straightforward integration into sample preparation and detection systems.



Figure 1. HSC-40 Hydrosol Concentrator

The HSC-40 was designed as a research instrument for the scientist. The system allows for use of an exceptionally wide range of hollow fiber concentration cells – providing means for

capturing bacteria, viruses, free DNA, and large molecules from liquids ranging from homogenized food samples to ultrapure water. Sample processing rates of up to 40 mL/min are supported.



Figure 2. Fieldable Hydrosol Concentrator

The fieldable unit provides a means of taking the instrument to the sample for processing of environmental waters, irrigation waters, and other samples that are more easily processed in the field.



Figure 3. Hydrosol Concentrator for Integration

Systems can be tailored for integration into a variety of sample preparation and detection systems. Standard systems provide flow rates of up to 40 mL/min and support a wide range of hollow fiber concentration cells. Flow rates of up to 3 L/min have been demonstrated and may be implemented into a readily integrated platform.

DATA:

The concentration efficiency of the InnovaPrep hydrosol concentrator has been extensively investigated during development, using calibration-quality polystyrene microspheres. The efficiencies shown in Table 1, below, are for concentrating 1.5 mL of fluid into 100 μ L. The processing time was less than 90 seconds.

Table 1. InnovaPrep Concentration Efficiency

Particle Size (μ m)	Represented Particle	Efficiency
4.5	Agglomerates of bacteria	95%
1.0	Single bacteria	85%
0.05	Viruses	75%
0.025	DNA, Lower limit for viruses	60%

Competing technologies cannot meet all the requirements for a universal microparticle hydrosol concentrator. Centrifugation, the traditionally used particle concentration technique, is not rapid and is not easily automated. Hollow Fiber and Flat Membrane concentration systems are under development by others, but have limitations that have been overcome by InnovaPrep. These technologies are compared to some key InnovaPrep performance parameters in Table 2.

The InnovaPrep has lowest possible final volume and is also capable of concentration of viruses, DNA, and other particles less than 100 nanometer. The ability to concentrate viruses is of key importance for bioterrorism defense applications.

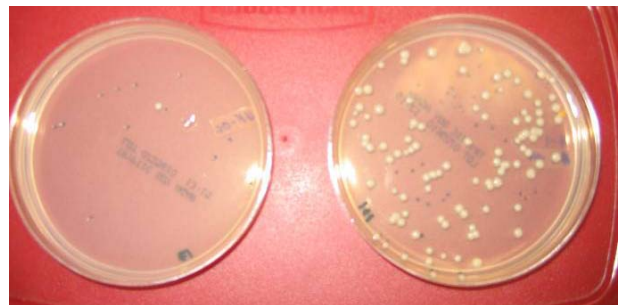
Table 2. Technology Comparison

Technology	InnovaPrep [®]	Hollow Fiber	Flat Membrane
Automated	Yes	Yes	Yes
Flow Rate ml/min	2 for 0.03 μ m 20 for 1.0 μ m	\leq 20	\geq 20
Final Vol.	0.01 ml and up	0.1 ml	1.0 ml
Efficiency	0.05 μ m 75% 1.0 μ m 85%	Bacteria 12%-72%	~90% (no size stated)
Viruses	Yes	No	No
Separations	Yes	No	No

A demonstration of the ability of the InnovaPrep to concentrate biological samples is shown below in Figure 4. An aerosol sample was taken over a period of several days by an independent California laboratory, using a high-volume air sampler like those used by U.S. EPA for their BioWatch Program. Two Petri dishes are shown in the figure. The dish on the left is from an un-concentrated environmental sample; on the right is a plate from the concentrated sample.

For the unconcentrated sample 100 μ L was plated, as is standard for plating and enumeration manual methods. For the concentrated sample the initial sample volume was 1.5 mL and the final volume was 100 μ L. The theoretical concentration was thus 15X. The efficiency of the InnovaPrep concentration was 87%, giving an actual concentration factor of 13.1X for the bacteria present in the starting sample. The plating was done in triplicate; the plates shown were the ones with the median number of colonies on them.

Figure 4. Bio-Concentration



SUMMARY:

The InnovaPrep has been demonstrated to be a rapid, effective hydrosol concentration technique. It reliably concentrates aqueous particle suspensions into final volumes as small as 50 μ L, appropriate for modern rapid analysis techniques. Commercial units (Figures 1, 2, 3) are currently being built, and integration of modules is supported by InnovaPrep LLC of Drexel, MO.

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