

**E-PAK is a family of radial flow adsorption cartridges developed specifically for pharmaceutical processings.**

Created with proprietary technology, E-PAK cartridges provide rapid adsorption kinetics at flow rates and processing capacities suitable for laboratory, pilot and commercial operations. They are designed for use with both organic and aqueous solvents, and incorporate design features useful for the production of active pharmaceutical ingredients (API).



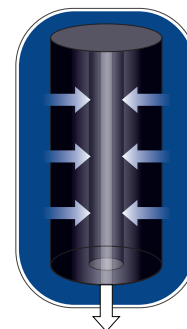
## Features & Benefits

- Proven cartridge design ensures rapid, simple & reliable technology
- High adsorption capacity and flow rate
- Fixed-bed design ensuring safer handling, clean-up and disposal
- Large adsorbent capacity in small area footprint increases product recovery & reduces solvent requirements

## Sorbents for E-PAK Cartridges

E-PAK cartridges are available in a range of sorbents to accommodate the broad range of processing requirements. Other adsorbents are available under request.

Sorbents for E-PAK		
Active Adsorbents	For Removal and/or Recovery of :	pH Operation
SiliaMetS Thiol	Pd, Ag, Hg, Os, Ru, Cu, Ir, Pb, Rh, Se & Sn	2 to 10
SiliaMetS DMT	Pd, As, Ir, Ni, Os, Pt, Rh, Ru, Se, Cd, Co, Cu, Fe, Sc & Zn	
SiliaMetS Imidazole	Cd, Co, Cu, Fe, Ir, Li, Mg, Ni, Os, W, Zn, Cr, Pd & Rh	
SiliaBond Amine		
SiliaMetS Diamine	Pd, Cr, Pt, W, Zn, Cd, Co, Cu, Fe, Hg, Ni, Pb, Ru, Sc & Se	
SiliaMetS Triamine		
SiliaFlash Bare Silica	Very vast range of organic impurities, metals, pigments...	2 to 9
Activated Carbons	Precious metal catalysts & colors	1 to 13



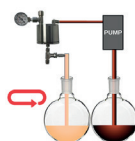
Out-to-in radial flow-through fixed porous adsorbent media

E-PAK cartridges are formed using a proprietary technology and chemically stable materials in common organic solvents. They have been tested and found satisfactory for use with the following commonly used solvents such as: Methanol, Dichloromethane, Ethyl acetate, Tetrahydrofuran, Toluene & N-ethyl-2-pyrrolidone.

## Various Ways of Using E-PAK

Depending on the application and how you prefer to work, E-PAK cartridges can be used in different ways as shown below.

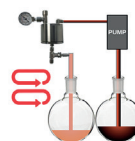
For a single pass usage, we suggest to run at very low flow rate compared to recirculation process, which can be run at higher flow rate.



Single Pass



Recirculation



Multiple Sequential Passes



2 Cartridges Method

### Case Study

Get your copy of our Case Study!

« Two-Steps Purification with E-PAK® Cartridges Following a Direct Pd-Catalyzed Borylation »

Contact us: [scavengers@silicycle.com](mailto:scavengers@silicycle.com)



# SiliaMetS® E-PAK® Portfolio

## Lab Scale

Lab scale cartridges are designed to facilitate the evaluations of small samples. Testing with loose media can be done with samples as small as a few milliliters and are normally done in advance of cartridge testing to identify the formula with the highest capacity to remove contaminants with the highest recovery.

Lab Scale Cartridges				
Cartridge Size Diameter x Height	Flow Rate Range	Pressure Drop $\Delta P$ (Psig) with w/1 cps Fluid	Media Weight	
			SiliaMetS & SiliaBond	SiliaFlash & Activated Carbons
5 x 1 cm	5 - 100 mL/min	$\leq 7.5$ psig	8 g	5 g
5 x 10 cm	50 - 500 mL/min	$\leq 5$ psig	75 g	50 g
5 x 25 cm	125 mL/min - 1 L/min	$\leq 5$ psig	200 g	125 g



## Pilot & Commercial Scale

E-PAK pilot scale cartridges provide rapid processing for volumes from 10 to hundreds of liters, and can establish the parameters upon moving to larger scales, since E-PAK achieve true linear scalability.

E-PAK commercial scale cartridges provide rapid processing for manufacturing operations needing to process batch sizes of > 10,000 liters or can be adapted for continuous operation using a duplex design.

Pilot & Commercial Scale Cartridges				
Cartridge Size Diameter x Height	Flow Rate Range	Pressure Drop $\Delta P$ (Psig) with w/1 cps Fluid	Media Weight	
			SiliaMetS & SiliaBond	SiliaFlash & Activated Carbons
<b>Pilot Scale</b>				
16.5 x 12.5 cm	0.95 - 2.5 L/min	$\leq 10$ psig	875 g	850 g
16.5 x 25 cm	1.9 - 5 L/min	$\leq 10$ psig	1.75 kg	1.7 kg
<b>Commercial Scale</b>				
16.5 x 50 cm	3.8 - 10 L/min	$\leq 10$ psig	3.5 kg	3.4 kg
16.5 x 100 cm	7.6 - 20 L/min	$\leq 10$ psig	7 kg	6.8 kg



Both Pilot and Commercial cartridges are provided with a Code 8 (closed top & open bottom end caps-bottom with double 2-222 Teflon® encapsulated Viton® o-ring) cartridge sealing configuration.

To meet commercial processing requirements, E-PAK cartridges can be operated in parallel for increased capacity. Contact us.

## Housings

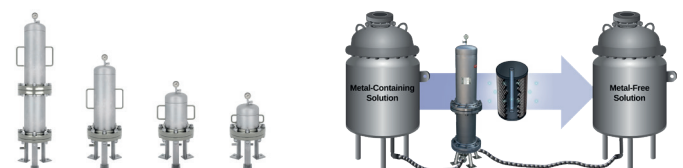
### Lab Scale

- Various housing length available (for 1 cm, 10 cm & 25 cm cartridges)
- Operated with standard pump
- Typical pressure rating for housing 150 psi
- Easy housing conversion for all lengths by changing the bowl



### Pilot & Commercial Scale

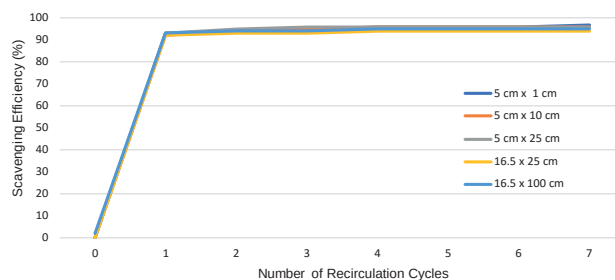
- A series of cartridge housings for operation of 1 to 12 cartridges
- Made in stainless steel or Hastelloy
- Code stamped ASME or CE
- Pressure rating: 150 psi
- Can be operated in parallel to process batch sizes of  $\geq 10,000$  L



## Scale-Up Linearity Demonstration

Using the same typical Suzuki-Miyaura reaction shown at left, with  $\approx 12$  molar equiv., scale-up reactions were performed from lab to commercial scale.

As you can see, each format behaved similarly in terms of efficiency and kinetics.



## Scale-Up Calculation

Although there are always exceptions, scale-up projections based on a linear extrapolation of adsorbent mass have proven to be quite accurate when test conditions including contact time, temperature, solvent type and contaminant and compound levels are held constant. The following table shows the scale-up/relative change in mass between lab, pilot and commercial size E-PAK cartridges available with scavengers.

Scale-Up calculation for Silica-Based Adsorbents							
Cartridge Sizes	5 x 1 cm	5 x 10 cm	5 x 25 cm	16.5 x 12.5 cm	16.5 x 25 cm	16.5 x 50 cm	16.5 x 100 cm
Scale-up Factor	-	10	25	80	220	440	875
Mass of Silica (g)	8	75	200	875	1,750	3,500	7,000
# mmol SiliaMetS Thiol (1.3 mmol/g)	10.4	98	260	1,138	2,275	4,550	9,100
# mmol SiliaMetS DMT (0.6 mmol/g)	4.8	45	120	525	1,050	2,100	4,200
# mmol SiliaMetS Imidazole (0.96 mmol/g)	7.7	72	192	840	1,680	3,360	6,720
# mmol SiliaBond Amine (0.2 mmol/g)	9.6	90	240	1,050	2,100	4,200	8,400
# mmol SiliaMetS Diamine (0.26 mmol/g)	10.2	96	256	1,120	2,240	4,480	8,960
# mmol SiliaMetS Triamine (1.11 mmol/g)	8.9	83	222	971	1,942	3,885	7,770
Bead volume (cm <sup>3</sup> )	18.8	188	470	2,375	4,750	9,500	19,000
Recommended Flow Rate (RT: 2.5 min)*	7.5	75	190	950	1,900	3,800	7,600
Flow Rate Range (mL/min)**	1 - 20	10 - 200	25 - 500	100 - 2,500	250 - 5,000	500 - 10,000	1,000 - 20,000
Conditioning	150 mL	600 mL	1.35 L	7.5 L	15 L	35 L	70 L

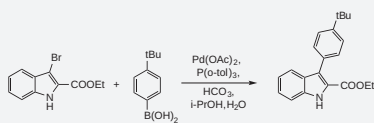
Results Explanation	
Cartridges	Measurement Methodology
Scale-up Factor	Mass of silica / 8 g (smaller size)
Mass of Silica (g)	Upon packing of cartridge
# mmol SiliaMetS XXX (X.X mmol/g)	Silica mass x typical loading of SiliaMetS / SiliaBond
Bead volume (cm <sup>3</sup> )	Cake total volume, excluding cap, including middle hole
Recommended Flow Rate (mL/min)*	For residence times of 2.5 minutes
Flow Rate Range (mL/min)**	For residence times from 1 to 20 minutes
Conditioning (mL)	3 x tank volume including cartridge

\* For residence times of 2.5 min

\*\* For residence times from 1 to 20 min

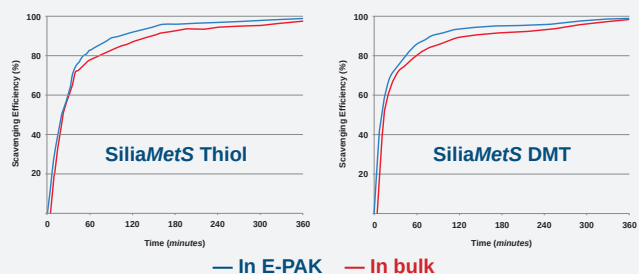
### Pd Scavenging: Bulk vs E-PAK

A typical Suzuki-Miyaura reaction was performed:



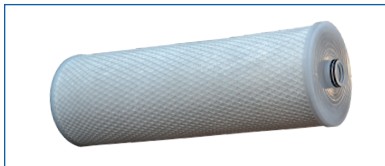
SiliaMetS in a 5 x 1 cm E-PAK and bulk ( $\approx 8$  molar equiv.), solution recirculated at 50 mL/min for E-PAK, contact time of 6 h for both.

No backpressure was observed for E-PAK with a slightly faster scavenging efficiency versus bulk.



Founded in 1995, SiliCycle® is specialized in high value silica-based and specialty products for chromatography, analytical and organic chemistry and purification.

### E-PAK® : FLOW CARTRIDGES FOR METAL REMOVAL NEW



- Eliminates the use of insoluble particulates in reactors
- High adsorption capacity & flow rate
- Various sizes available for easy scale-up from lab to industrial scale

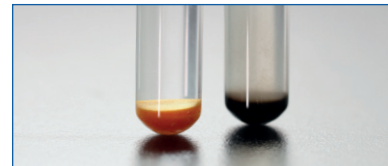
### METAL & ORGANIC SCAVENGING



Removal of:

- Metals
- Electrophiles & Nucleophiles
- Potential Genotoxic Impurities (PGI)
- Other organic residues

### CATALYSIS & SYNTHESIS



- Couplings (*Suzuki, Stille, Heck, ...*)
- Debenzylations & Hydrogenations
- Oxidations
- And Many More Reactions

### SAMPLE PREPARATION



- SPE & Well Plates
- Micro-SPE Tips
- QuEChERS & FaPex NEW
- SPE Hardware & Manifold

### HIGH PRESSURE CHROMATOGRAPHY



- Bulk Sorbents
- HPLC Columns
- SFC Columns
- Guard Cartridges & Accessories

### LOW PRESSURE CHROMATOGRAPHY



- Bulk Silica Gels (*Irregular & Spherical*)
- Bonded Phases
- TLC Plates
- Pre-packed Flash Cartridges

### EXTRACTION & PURIFICATION NEW



- Extraction & Purification Services
- Essential Oils & Hydrosols
- Purified Natural Extracts
- Probiotics & Bacteriocins

### R&D SERVICES



- Scavenging Screening
- Method Development & Optimization
- Impurities Identification
- Custom Column Packing