

[ SEP-PAK SAMPLE EXTRACTION PRODUCTS ]

**Sep-Pak<sup>®</sup>**  
Sample Extraction Products



**THE ORIGINAL AND MOST REFERENCED  
SILICA-BASED SPE PRODUCTS**

**Waters**  
THE SCIENCE OF WHAT'S POSSIBLE.<sup>®</sup>

## [ SEP-PAK CARTRIDGES ]

### Pioneering a Revolution in Modern Sample Preparation

Sep-Pak® Cartridges catalyzed the dramatic growth of an industry devoted to solid-phase extraction (SPE). After 35 years of success in streamlining sample preparation, Sep-Pak Cartridges continue to be the most widely referenced SPE products in the world [by more than a nine-fold margin, > 137,000 articles!\*].

Sep-Pak Cartridges are specified in many official methods including those published by the U.S. EPA, AOAC International, ASTM, NIOSH, CDFA, and the JPMHLW.

Generations of citations five, six, or more levels deep may be traced back ultimately to a multitude of seminal published protocols—an enduring, ever expanding testament to the consistent ability of Sep-Pak Cartridges to solve important sample preparation problems reproducibly in laboratories around the world—and to Waters commitment to long-term customer success.\*\*

Since 1978, separation scientists throughout the world have used Sep-Pak sample extraction products with confidence for rapid sample preparation.

\* The number of hits returned by a search on June 2, 2013, in GOOGLE® Scholar for articles mentioning “Sep-Pak” and variant spellings; citations and patents were excluded.

\*\* More than six thousand references to the use of Sep-Pak Cartridges may be found by searching on [waters.com](http://waters.com).



## SPE IS LIQUID CHROMATOGRAPHY

Sep-Pak Cartridges use the code of liquid chromatography and a broad polarity spectrum of sorbents—including silica, acidic, neutral, and basic aluminas, Florisil™, and a selection of bonded silicas—to:

Derivatize analytes using solid-phase reagents.

Fractionate classes of compounds.

Remove sample constituents that elute after the analytes of interest, or are strongly adsorbed on, LC columns.

Remove sample constituents that coelute with an analyte of interest on LC columns.

**Sep-Pak®**  
Sample Extraction Products



Desalt samples.

Exchange solvents.

Enrich sample components present in low concentration.

### Benefits—Sep-Pak Cartridges Streamline Modern Sample Preparation

When compared to other sample preparation processes, solid-phase extraction using Sep-Pak Cartridges:

<b>Lowers Cost</b>	<ul style="list-style-type: none"> <li>lower solvent consumption</li> <li>lower reagent consumption</li> <li>less apparatus</li> </ul>
<b>Increases Recoveries</b>	<ul style="list-style-type: none"> <li>minimal sample transfer</li> </ul>
<b>Simplifies Protocol</b>	<ul style="list-style-type: none"> <li>fewer steps</li> </ul>
<b>Enhances Safety</b>	<ul style="list-style-type: none"> <li>less exposure to toxic agents</li> <li>ease of disposal</li> </ul>
<b>Improves Accuracy</b>	<ul style="list-style-type: none"> <li>no cross contamination</li> </ul>
<b>Avoids Emulsion Problems</b>	<ul style="list-style-type: none"> <li>less sample handling</li> <li>less complication</li> </ul>
<b>Eliminates Transport of Samples to Lab</b>	<ul style="list-style-type: none"> <li>direct field sampling</li> </ul>
<b>Reduces Harm to Labile Samples</b>	<ul style="list-style-type: none"> <li>minimal evaporation</li> </ul>
<b>Minimizes Glass Breakage</b>	<ul style="list-style-type: none"> <li>less glassware used, less to wash</li> </ul>

### What is SPE?

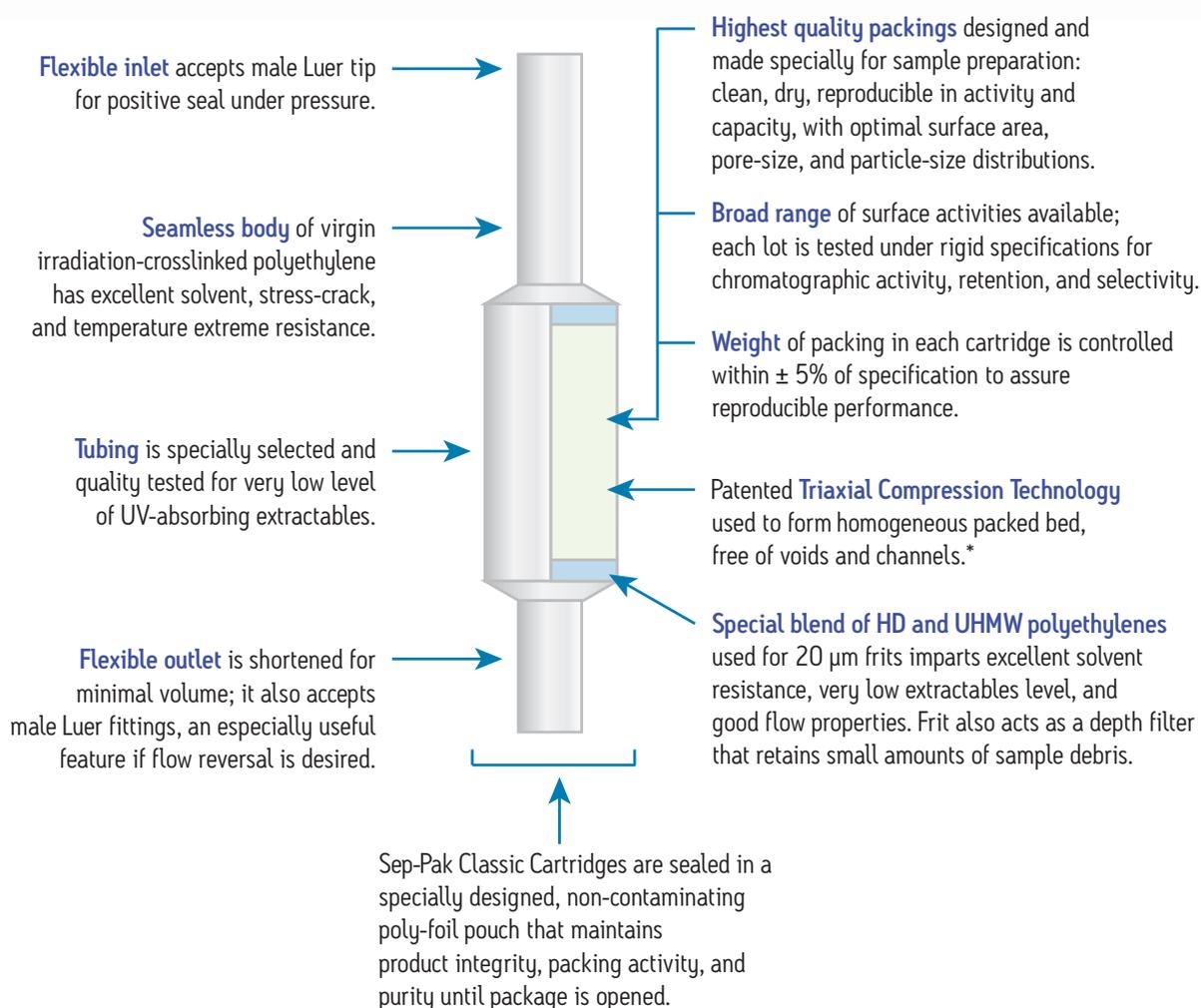
Don't be confused by the term solid-phase extraction [SPE]. A typical SPE device has 50 times more separation power than a simple, single liquid-liquid extraction. SPE is actually column liquid-solid chromatography. Since SPE is liquid chromatography [LC], its practice is governed by LC principles. A sample is introduced into a column or a cartridge device containing a bed of appropriate particles, or other form, of a chromatographic packing material [stationary phase]. Solvent [mobile phase] flows through the bed. By choosing an appropriate combination of mobile and stationary phases, sample components may pass directly through the column bed, or they may be selectively retarded or retained.

# ANATOMY OF A SEP-PAK CARTRIDGE

## [ Sep-Pak Classic ]

### A Precision Chromatographic Tool for Sample Enrichment and Purification

Here are ten unique features that have set Sep-Pak Classic Cartridges apart from the competition and made them the most widely-referenced column liquid-solid extraction cartridges available today.

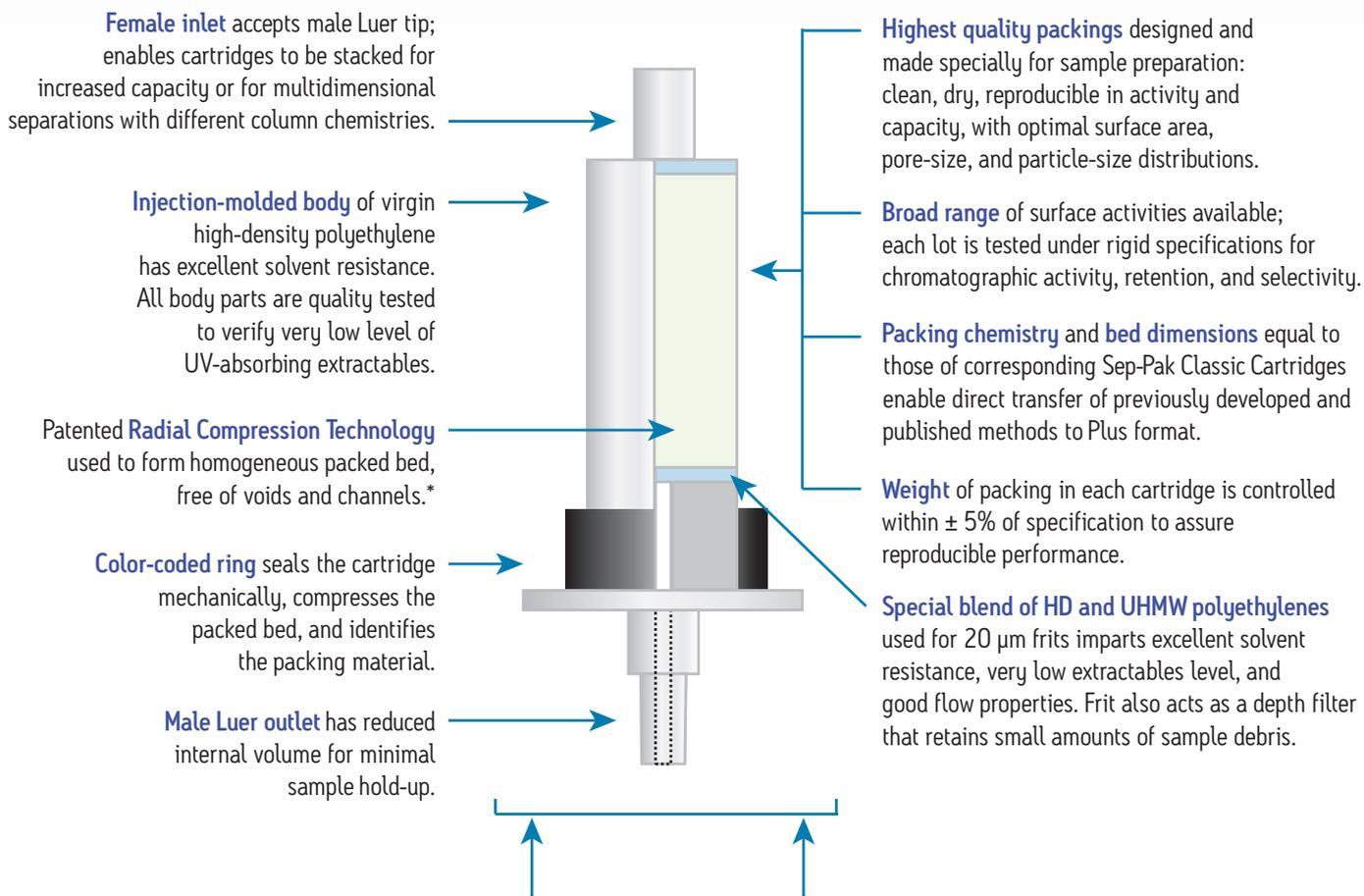


\* Patrick D. McDonald, Richard V. Vivilecchia, and David R. Lorenz, *Triaxially Compressed Packed Beds*, U.S. Patent 4,211,658 [1980].

## [ Sep-Pak Plus ]

## The Standard Among Devices for Sample Enrichment and Purification

Here are twelve unique features that make Sep-Pak Plus Cartridges the finest column liquid-solid extraction cartridges in the world.



Sep-Pak Plus Cartridges are sealed in a specially designed, non-contaminating poly-foil pouch that maintains product integrity, packing activity, and purity until package is opened.

Tough shell, large outlet flange, and precise axial alignment of all body parts make Sep-Pak Plus Cartridges suitable for robotic applications while also enhancing convenience for manual operation. Standard dimension Luer fittings may be connected readily to positive-pressure or vacuum-flow devices.

\* Patrick D. McDonald and Carl W. Rausch, *Radial Compression of Packed Beds*, U.S. Patent 4,250,035 [1981].

SIMPLICITY,  
SELECTIVITY,  
SPEED.



No matter what your analyte of interest or sample type [chemical, environmental, food, or biological matrix], the wide variety of Sep-Pak sorbents and device formats [more than 200 combinations] and tens of thousands of published procedures make it very likely that you will find a Sep-Pak sample extraction product to meet your analytical challenge.

## General Elution Protocols

There are two general strategies for isolating and cleaning up sample components of interest:

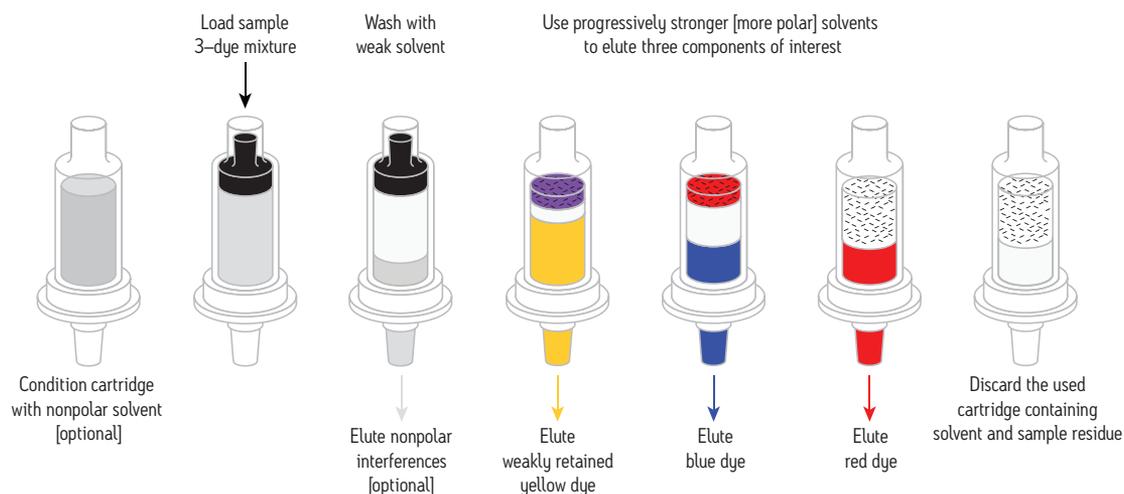
1. Adsorb matrix interferences while components of interest pass through the cartridge unretained.
2. Adsorb components of interest while matrix interferences pass through the cartridge unretained.

The first strategy is usually chosen when the desired sample component is present in high concentration. When components of interest are present at low levels, or multiple components of widely differing polarities need to be isolated, then the second strategy is generally employed. Trace enrichment of compounds present at extremely low levels and concentration of dilute samples are also achieved by the second strategy.

## Normal-Phase Chromatography

This mode is classically used to separate neutral organic compounds whose chemical nature ranges from hydrophobic to moderately polar.

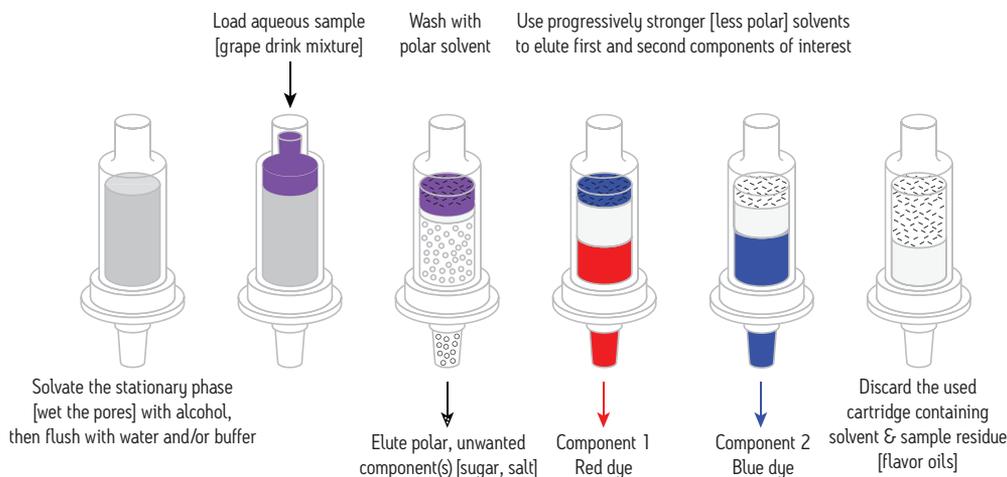
To perform normal-phase chromatography with SPE cartridges, use a step gradient of nonpolar solvents with a polar packing material. This procedure is illustrated in the figure here for a sample containing a mixture of three neutral, relatively non-polar organic dyes [yellow, red, and blue] that appears black when initially loaded onto the cartridge bed.



## Reversed-Phase Chromatography

Because of the multiplicity of aqueous samples spanning a breadth of applications from environmental water to fruits and vegetables, from beverages to biological fluids, reversed-phase chromatography has become the predominant mode of SPE.

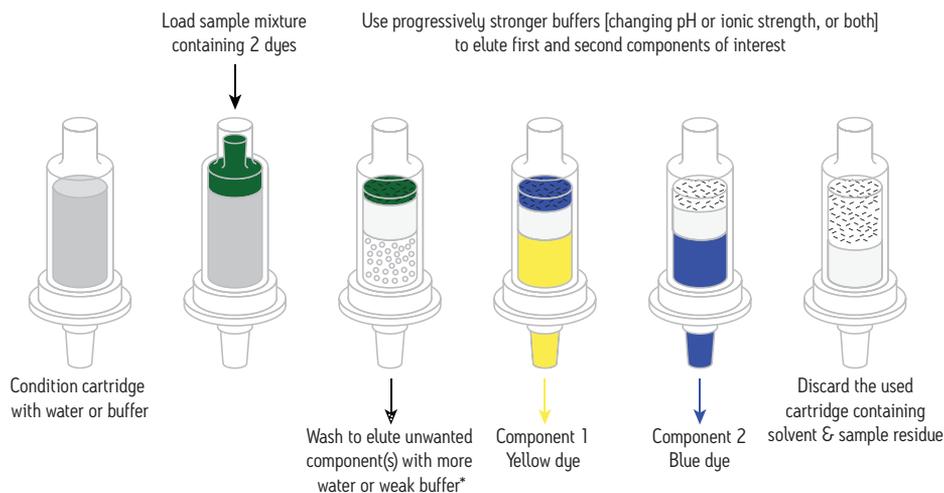
To perform reversed-phase chromatography with SPE cartridges, use a gradient of strongly to weakly polar solvents [from weak to strong solvent elution strength] with a non-polar packing material. This procedure is illustrated in the figure here for a sample of an aqueous grape drink containing two polar food dyes [red and blue], as well as sugar and artificial flavor [but no real grape juice!]. As prepared, this drink appears light purple in a glass, since the dye concentration is dilute. When a portion is loaded onto a prepared SPE cartridge, the strongly retained dyes become concentrated near the inlet in a dark purple band.



## Ion-Exchange Chromatography

Compounds that are ionic or ionizable are often best isolated using some form of ion-exchange chromatography. This separation mode is orthogonal to the more widely used normal-phase and reversed-phase modes and provides a powerful, selective second dimension to sample preparation protocols.

To perform ion-exchange chromatography with Sep-Pak cartridges, use a gradient of pH or ionic strength with an ion exchange packing material. This procedure is illustrated in the figure below for a sample of an aqueous mixture of two ionic dyes with different  $pK_a$  values. When loaded onto the cartridge, both are strongly retained, and the combination of blue and yellow components appears as a green band near the inlet.



\* In mixed-mode ion exchange, an intermediate wash with organic solvent may be used to elute neutral compounds (or those with same charge as sorbent) bound via hydrophobic interaction.

## SEP-PAK DEVICE FORMATS

### Sep-Pak Plus Cartridges: Maximum Versatility

Plus cartridges feature a state-of-the-art packing process as well as a precision design, suited to robotic applications, that also makes manual use even more convenient. Certain sorbents are available in short-body, and others in long-body, configurations. Connections can be made to different types of devices such as filter units, positive-flow pumps and syringes, vacuum manifolds, some automated sample processors, and in-line reaction systems (e.g., for positron emission tomography [PET] applications).



Plus cartridges can be used with liquid and gas samples and have the unique capability for reversing flow direction, a useful feature for trace enrichment applications. Interstitial volumes and weights of sorbents in the short- and long-body configurations match those of corresponding Classic cartridges, facilitating method transfer.

### Sep-Pak Light Cartridges: Reduced Volume

Light cartridges are the same size and have the same features as, but about one-third the internal volume of, the short-body Plus cartridges. A distinctive “finned” outer body also features a color-coded compression ring. This cartridge format allows you to scale down your sample preparation protocols when sample size is limited or when excessive dilution is a concern. Fractions can be eluted in a minimal volume to improve sensitivity and reduce solvent consumption.



### Sep-Pak Classic Cartridges: Most Widely Referenced

Classic cartridges are the original Sep-Pak cartridges introduced in January, 1978. They contain the same high quality packing materials as the other cartridge types and match the interstitial volumes of Plus cartridges with corresponding short [0.5 mL] and long [1 mL] bodies. This means that you can transfer published methods developed on Classic cartridges directly to the more versatile Plus cartridges.



### Sep-Pak Vac Cartridges: Economical Automation

Vac cartridges deliver the option of minimum cost sample preparation. The cartridges consist of molded, high purity polypropylene “syringe-barrel” bodies with two polyethylene frits to contain the packing material. A standard male-Luer tip permits use with multi-position vacuum manifolds. Cartridge sizes range from 1 cc to 60 cc and may contain sorbent weights from 5 mg up to 10 g or more, respectively. Color-coded printing on the syringe barrels identifies the brand and sorbent.



### Sep-Pak Vac RC Cartridges: Larger Reservoir Capacity

Vac RC cartridges feature an integral 20-cc funnel-shaped reservoir and contain 10 to 500 mg of sorbent. They can be used with robotic sample preparation equipment or with vacuum manifolds. The larger reservoir permits convenient processing of greater volumes of samples or solvents. This reduces set-up time and lowers costs associated with the use of separate reservoirs. Sorbents are identified by color-coded printing on the cartridge bodies.



## Sep-Pak 96-Well Extraction Plates: High Throughput Automation



Selected Waters Sep-Pak sorbents are available in a unique, multi-capacity, award-winning 96-well plate format designed by Waters. Plates are molded from high-purity polypropylene.

Wells are filled with the same high quality sorbents and frit materials available in the respective cartridge formats. Fluid capacity above the top frit in each well is approximately 2 mL. Thus, SPE protocols developed using Sep-Pak cartridges may be scaled down, or transferred directly, to 96-well plates based upon the corresponding weight of sorbent in each well [e.g., 25, 40, or 100 mg].

## Sep-Pak 96-Well $\mu$ Elution Plates: Small Samples



Waters Sep-Pak tC<sub>18</sub> sorbent is available in a unique, patented\*\* 96-well  $\mu$ Elution plate format designed by Waters. Plates—molded from high-purity polypropylene—are ideal for SPE cleanup, and analyte enrichment from, small sample volumes.

Wells are filled with the same high quality sorbent and frit materials available in the respective cartridge format. Sample fluid capacity above the top frit in each well is approximately 200  $\mu$ L.

No evaporative concentration is necessary with eluate volumes as low as 25  $\mu$ L. Analyte concentrations may be increased up to 15-fold.

The use of Sep-Pak 96-Well Extraction and  $\mu$ Elution Plates—compatible with most liquid-handling robotic systems for automated, reliable, high-throughput SPE [HT–SPE]—can easily keep pace with LC–MS or GC–MS systems.

\*\* Raymond P. Fisk, Pamela C. Iraneta, Yuri Tuvim, Edouard S.P. Bouvier, Jonathan Belanger, and Martin Gilar, *Device for solid phase extraction and method for purifying samples prior to analysis*, U.S. Patents: **6,723,236** [2004]; **7,052,611** [2006]; **7,192,525** [2007].

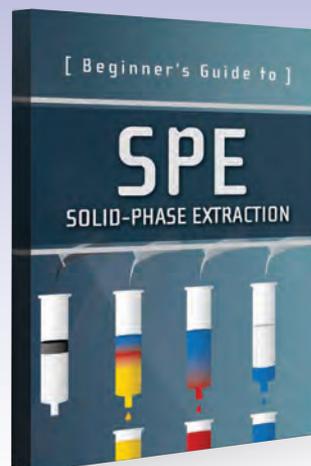
## Beginner's Guide to SPE (Solid-Phase Extraction)

by Joseph C. Arsenault

Learn the fundamentals of SPE principles, strategies, and practice in this book.

Order your copy now.

[www.waters.com/speprimer](http://www.waters.com/speprimer)





	Vac 3 cc/200 mg	Vac 3 cc/500 mg	Vac RC/500 mg	Vac 6 cc/500 mg	Vac 6 cc/1 g	Vac 12 cc/2 g	Vac 20 cc/5 g	Vac 35 cc/10 g
	50/box	50/box	50/box	30/box	30/box	20/box	20/box	10/box
Sorbent	Part No. Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*
C <sub>18</sub>	WAT054945 0.42 mL	WAT020805 0.8 mL	WAT036945 0.8 mL	WAT043395 1.2 mL	WAT036905 2.0 mL	WAT036915 3.6 mL	WAT036925 8.0 mL	WAT043345 16.8 mL
tC <sub>18</sub>	WAT054925 0.34 mL	WAT036815 1.0 mL	WAT043425 1.0 mL	WAT036790 1.1 mL	WAT036795 1.9 mL	WAT043380 3.5 mL	WAT043365 7.8 mL	WAT043350 16.3 mL
C <sub>8</sub>	WAT054940 0.34 mL	WAT036780 1.0 mL	WAT043430 1.0 mL	WAT054525 1.1 mL	WAT054570 1.9 mL	WAT054615 3.5 mL	WAT054660 7.8 mL	WAT054700 16.3 mL
tC <sub>2</sub>	—	WAT052715 1.0 mL	—	—	WAT052705 1.9 mL	—	—	—
Silica	WAT054930 0.53 mL	WAT020810 1.2 mL	WAT036950 1.2 mL	WAT043400 1.2 mL	WAT036910 1.9 mL	WAT036920 3.9 mL	WAT036930 11.0 mL	WAT043355 23.4 mL
Florisil	—	WAT020815 0.8 mL	WAT043435 0.8 mL	WAT043405 1.2 mL	WAT043390 2.0 mL	WAT043385 3.6 mL	WAT043370 8.0 mL	WAT043360 16.8 mL
Accell Plus CM	—	WAT020855 1.1 mL	WAT054505 1.1 mL	WAT054545 1.2 mL	WAT054590 1.9 mL	WAT054635 3.5 mL	WAT054675 7.8 mL	WAT054720 16.3 mL
Accell Plus QMA	—	WAT020850 1.1 mL	WAT054500 1.1 mL	WAT054550 1.2 mL	WAT054595 1.9 mL	WAT054640 3.5 mL	WAT054680 7.8 mL	WAT054725 16.3 mL
Alumina A	—	WAT020820 0.4 mL	—	WAT054535 0.5 mL	WAT054580 0.8 mL	WAT054620 1.8 mL	WAT054670 3.9 mL	WAT054710 8.2 mL
Alumina B	—	WAT020825 0.4 mL	—	WAT054540 0.5 mL	WAT054585 0.8 mL	WAT054625 1.8 mL	WAT054665 3.9 mL	WAT054715 8.2 mL
Alumina N	—	WAT020830 0.4 mL	WAT043485 0.4 mL	WAT054530 0.5 mL	WAT054575 0.8 mL	WAT054630 1.8 mL	WAT043375 3.9 mL	WAT054705 8.2 mL
Aminopropyl (NH <sub>2</sub> )	—	WAT020840 0.8 mL	WAT054515 0.8 mL	WAT054560 1.2 mL	WAT054605 2.0 mL	WAT054650 3.6 mL	WAT054695 8.0 mL	WAT054740 16.8 mL
PSA	186004598	186004536 0.8 mL	186004568 0.8 mL	186004563 1.2 mL	186004537 2.0 mL	186004564 3.6 mL	186004565 8.0 mL	186004566 16.8 mL
Cyanopropyl (CN)	WAT054935 0.42 mL	WAT020835 0.8 mL	—	WAT054555 1.2 mL	WAT054600 2.0 mL	WAT054645 3.6 mL	WAT054685 8.0 mL	WAT054730 16.8 mL
Diol	—	WAT020845 1.0 mL	WAT054520 1.0 mL	WAT054565 1.1 mL	WAT054610 1.9 mL	WAT054655 3.5 mL	WAT054690 7.8 mL	WAT054735 16.3 mL

\*Hold up volume

### Sep-Pak Connections Kit

Description	Part No.
Sep-Pak Connections Kit	WAT011400

### Sep-Pak Reservoir

Description	Qty.	Part No.
Sep-Pak Reservoir, 30 cc	40/box	WAT011390

### Additional Product Information

[www.waters.com/seppak](http://www.waters.com/seppak)

Description	Literature Code
Beginner's Guide to SPE (Solid-Phase Extraction)	715003405
Waters Sorbent Selection Guide for Solid-Phase Extraction Wall Chart	720002007EN

[Search by literature code at waters.com](http://www.waters.com)

# SEP-PAK CARTRIDGE SELECTION GUIDE



	Plus Short	Plus Long	Plus Light	Classic Short	Classic Long	Vac 1 cc/50 mg	Vac 1 cc/100 mg	Vac RC/100 mg
	50/box	50/box	50/box	50/box	50/box	100/box	100/box	50/box
Sorbent	Part No. Mass/Volume*	Part No. Mass/Volume*	Part No. Mass/Volume*	Part No. Mass/Volume*	Part No. Mass/Volume*	Part No. Volume*	Part No. Volume*	Part No. Volume*
C <sub>18</sub>	WAT020515 360 mg/0.7 mL	WAT023635 820 mg/1.6 mL	WAT023501 130 mg/0.3 mL	WAT051910 360 mg/0.85 mL	—	WAT054955 0.13 mL	WAT023590 0.2 mL	WAT036935 0.2 mL
tC <sub>18</sub>	WAT036810 400 mg/0.8 mL	WAT036800 900 mg/1.4 mL	WAT036805 145 mg/0.4 mL	—	—	WAT054960 0.11 mL	WAT036820 0.25 mL	WAT043410 0.25 mL
C <sub>8</sub>	WAT036775 400 mg/0.8 mL	—	WAT036770 145 mg/0.4 mL	—	—	WAT054965 0.11 mL	WAT036785 0.25 mL	WAT043415 0.25 mL
tC <sub>2</sub>	WAT052720 400 mg/0.8 mL	—	WAT052725 145 mg/0.4 mL	—	—	—	WAT052710 0.25 mL	—
Silica	—	WAT020520 690 mg/1.6 mL	WAT023537 120 mg/0.4 mL	—	WAT051900 690 mg/2.0 mL	WAT054980 0.15 mL	WAT023595 0.25 mL	WAT036940 0.25 mL
Florisil	—	WAT020525 910 mg/1.4 mL	WAT023543 145 mg/0.3 mL	—	WAT051960 900 mg/1.7 mL	WAT054985 0.12 mL	WAT023600 0.2 mL	—
Accell™ Plus CM	WAT020550 360 mg/0.8 mL	—	WAT023531 130 mg/0.4 mL	WAT010910 360 mg/1.1 mL	—	—	WAT023625 0.25 mL	—
Accell Plus QMA	WAT020545 360 mg/0.8 mL	—	WAT023525 130 mg/0.4 mL	WAT010835 360 mg/1.1 mL	—	—	WAT023620 0.25 mL	WAT043460 0.25 mL
Alumina A	—	WAT020500 1710 mg/1.2 mL	WAT023549 280 mg/0.35 mL	—	WAT051800 1850 mg/1.8 mL	—	WAT023575 0.1 mL	—
Alumina B	—	WAT020505 1710 mg/1.2 mL	WAT023555 280 mg/0.35 mL	—	WAT051820 1850 mg/1.8 mL	—	WAT023580 0.1 mL	—
Alumina N	—	WAT020510 1710 mg/1.2 mL	WAT023561 280 mg/0.35 mL	—	WAT051810 1850 mg/1.8 mL	—	WAT023585 0.1 mL	—
Aminopropyl (NH <sub>2</sub> )	WAT020535 360 mg/0.7 mL	—	WAT023513 130 mg/0.3 mL	WAT010830 360 mg/0.85 mL	—	—	WAT023610 0.2 mL	WAT043475 0.2 mL
PSA	186004538 360 mg/0.7 mL	—	186004578 130 mg/0.3 mL	186004560 360 mg/0.85 mL	—	186004562 0.1 mL	186004561 0.2 mL	186004567 0.2 mL
Cyanopropyl (CN)	WAT020540 360 mg/0.7 mL	—	WAT023507 130 mg/0.3 mL	WAT010823 360 mg/0.85 mL	—	WAT054975 0.13 mL	WAT023615 0.2 mL	—
Diol	WAT020530 360 mg/0.8 mL	—	WAT023519 130 mg/0.4 mL	—	—	—	WAT023605 0.25 mL	WAT043480 0.25 mL

\*Hold up volume

## Sep-Pak 96-Well Plates

Description	Part No.
Sep-Pak tC <sub>18</sub> 25 mg Plate	186002319
Sep-Pak tC <sub>18</sub> 40 mg Plate	186002320
Sep-Pak tC <sub>18</sub> 100 mg Plate	186002321
Sep-Pak Accell Plus QMA 100 mg Plate	186001917
Sep-Pak C <sub>18</sub> 40 mg Plate	186003966

## Sep-Pak 96-Well µElution Plates

Description	Part No.
Sep-Pak tC <sub>18</sub> µElution Plate	186002318

## Sep-Pak DNPH-Silica Cartridge

Description	Qty.	Part No.
Sep-Pak DNPH-Silica Short Body Cartridge	20/box	WAT037500
Sep-Pak DNPH-Silica Long Body Cartridge	20/box	WAT039550

## Sep-Pak XPoSure Aldehyde Sampler Cartridge

Description	Qty.	Part No.
XPoSure™ Aldehyde Sampler Cartridge	20/box	WAT047205

## Sep-Pak Ozone Scrubber

Description	Qty.	Part No.
Ozone Scrubber	20/box	WAT054420

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Austria 43 1 877 18 07  
Australia 61 2 9933 1777  
Belgium and Luxembourg 32 2 726 1000  
Brazil 55 11 4134 3788  
Canada 1 800 252 4752  
China 86 21 6156 2666  
Czech Republic 420 2 617 11384  
Denmark 45 46 59 8080  
Finland 358 9 5659 6288  
France 33 1 30 48 72 00  
Germany 49 6196 400 600  
Hong Kong 852 2964 1800  
Hungary 36 1 350 5086  
India 91 80 2837 1900  
Ireland 353 1 448 1500  
Israel 9723 3731391  
Italy 39 02 265 0983  
Japan 81 3 3471 7191  
Korea 82 2 6300 4800  
Mexico 52 55 52 00 1860  
The Netherlands 31 76 508 7200  
Norway 47 6 384 6050  
Poland 48 22 101 5900  
Portugal 351 21 893 61 77  
Puerto Rico 1 787 747 8445  
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