



ENTECH
INSTRUMENTS

See What's Really There™



FEVE

FULL EVAPORATIVE VACUUM EXTRACTION

Complete analysis of SVOCs in drinking, ground, and waste water, beverages, and samples with low solids content.

Version 2.0

A new vacuum extraction technique that completely evaporates the volatile matrix through Sorbent Pens while retaining GC compatible compounds

FEVE
FULL EVAPORATIVE VACUUM EXTRACTION

Introducing FEVE - What is it?

Full Evaporative Vacuum Extraction, or FEVE, is a new Sorbent Pen extraction technique that eliminates the need to “compete” with the matrix for compound affinity, because the complete matrix is evaporated “through” the sorbent during the extraction process, leaving no choice for the compounds of interest but to be transferred to the Sorbent Pens. Therefore, all polar and non-polar target compounds are recovered equally, which is not the case with virtually all other extraction methods. FEVE uses the volatilizing matrix as the carrier gas rather than having to provide an external carrier gas, which dramatically reduces the potential for channeling and analyte breakthrough. The total volume of gas can be 30x less when using the evolving matrix rather than introducing a carrier gas (N₂ or He), and matrix evaporation rates of only 1-2cc/min virtually eliminates the negative effects of sorbent “channeling” during trapping. FEVE is most effective when the sample matrix has a low solid or suspended solids content, and when the matrix is relatively volatile, such as a primarily water, alcohol, or combined water/alcohol matrix.

FEVE – Technique Selection Guide

Sample Type: Volatile liquid matrix with low solid content

Extraction Temperatures: 30° - 40° C to remove volatile matrix, 50 - 280° C final vial heating

Extraction Times: 2-6 hours, 1-30 samples

Operational Mode: Dynamic trapping using volatilizing matrix, followed by Static Vacuum Extraction at 1 Torr or lower

Analyte BP Range: 100° C to 600° C

Vial Sizes: 2mL or 6mL

Typical 5800 Mode: SPLIT or SPLITLESS

Water Management: Completely removed during Dynamic Evaporation Stage

FEVE performs the extraction in 2 sequential stages:

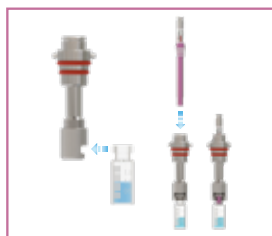
Stage 1 Dynamic transfer at 30-40° C at a vacuum of 10-15 Torr, using the evolving matrix to sweep the compounds of interest onto the sorbent while the matrix passes through unretained.

Stage 2 Static transfer under an increased vacuum (0.5 - 2 Torr) and higher sample vial temperatures to recover any remaining compounds still in the vial that were not delivered during the initial dynamic transfer step.

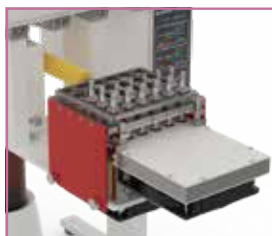


This fully automated 2-Stage process recovers a wider range of polar to non-polar compounds better than other techniques because it forces everything to pass through the sorbent. By removing matrix competition, compound recovery can dramatically improve.

FEVE30 Process



1 Weigh/measure sample into vial, attach FEVE vacuum sleeve and insert Sorbent Pen



2 Load up to 30 Pens and sample vials into FEVE30 Tray

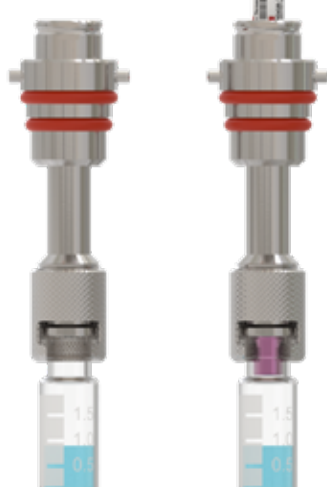
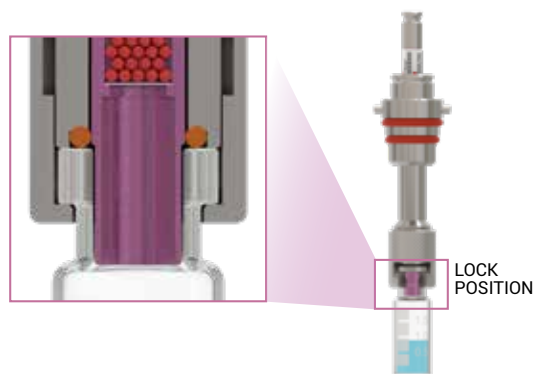


3 Begin automated extraction process via SPRINT control software



4 Desorb Sorbent Pens using 5800 SPDU manually or using an SPR40 Autosampler

FEVE employs FSP Sorbent Pens, a modified version of standard Headspace HSP Pens. These Pens have reduced diameters at their ends, allowing them to fit into a 2mL x 11mm crimp top vial, ensuring that the compounds end up inside the Pen rather than on the top of the vial. Once the sample is accurately measured, the vial can be easily slid into place through a side window in the FEVE sleeve sealing nut without having to remove the nut completely. Upon insertion of the FSP Sorbent Pen, a few quick rotations of the lock nut will create a vacuum-tight seal between the vial, Pen, and vacuum sleeve. Then the entire assembly is placed into the 30-position FEVE30-2 module, creating a vacuum tight seal with the top vacuum plate using a unique Press/Twist/Lock solution. Very simple to master, yet very effective in creating vacuum tight connections.

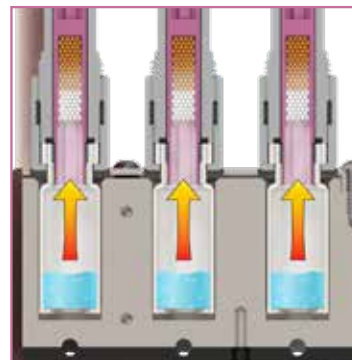


FEVE – A Green, Highly Sensitive Technique for Water Analysis

For analysis of SVOCs in water, just 1mL of sample provides the same sensitivity as 1L of water performing a Liquid/Liquid extraction that only delivers 1ul of the final 1000uL extract to a GCMS for analysis. In contrast, FEVE delivers 100% of the extract to the GCMS or GCMSMS, allowing the same sensitivity while using 1000x less sample. Channeling of the compounds through the adsorbent material is avoided by evaporating slowly, to improve recovery while avoiding carryover. The water vapor carries most compounds boiling under 350° C to the adsorbent without the risk of channeling into the sorbent, and then a second stage under an even higher vacuum diffusively transfers compounds boiling from 350° C to over 550° C with zero chance of channeling due to the complete elimination of a water carrier gas at this stage of the extraction.

It is like “Cheating” when doing SVOC Analysis in Water!!!

By removing the volatile fraction, FEVE does not have to compete against the sample matrix for “greater solubility”, like SBSE, full immersion SPME, Solvent Extraction, or SPE. After water removal, the glass sample vial becomes equivalent to a glass GC injection liner, so heating of the vial transfers any remaining SVOCs to the sorbent, but at relatively low temperatures (200° C) due to operating at 1-2 Torr of vacuum. The use of lower temperatures allows the recovery of many compounds that were not considered as GC compatible using other extraction techniques.



FEVE30 Analysis Cycle - Simple and Highly Reproducible

Step 6 Clean vacuum sleeves and O-rings without solvents using the 3700 which both steam cleans and dry cleans parts under prior to reuse.

Step 1 Introduce sample and recovery surrogates into vial, assemble into vacuum sleeve, and insert FSP Sorbent Pen.

Step 2 Load Vial/Pen assemblies into FEVE30 module, perform automated leak check followed by automated extraction using SPRINT software. A water condensing cold trap eliminates any impact of liquid water in the vacuum pump.

Step 3 Unload Pens and place into Isolation tray for transfer to the GCMS Lab.

Step 4 Perform Automated Split or Splitless analysis of the Pens using GCMS.

Step 5 Sorbent Pens are Ready for Re-use.

FEVE30 FULL EVAPORATIVE VACUUM EXTRACTION



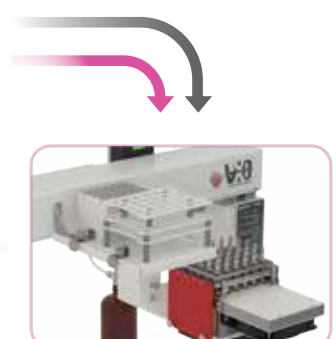
FEVE Sample Shuttle Optimizes Water Lab Work Flow



FEVE Shuttle allows for an organized movement of samples and extracts through an environmental laboratory.



FEVE Water Sample Loading



FEVE Water Sample Extraction



FEVE Vacuum Sleeve Cleanup



GCMS Lab Sorbent Pen Analysis



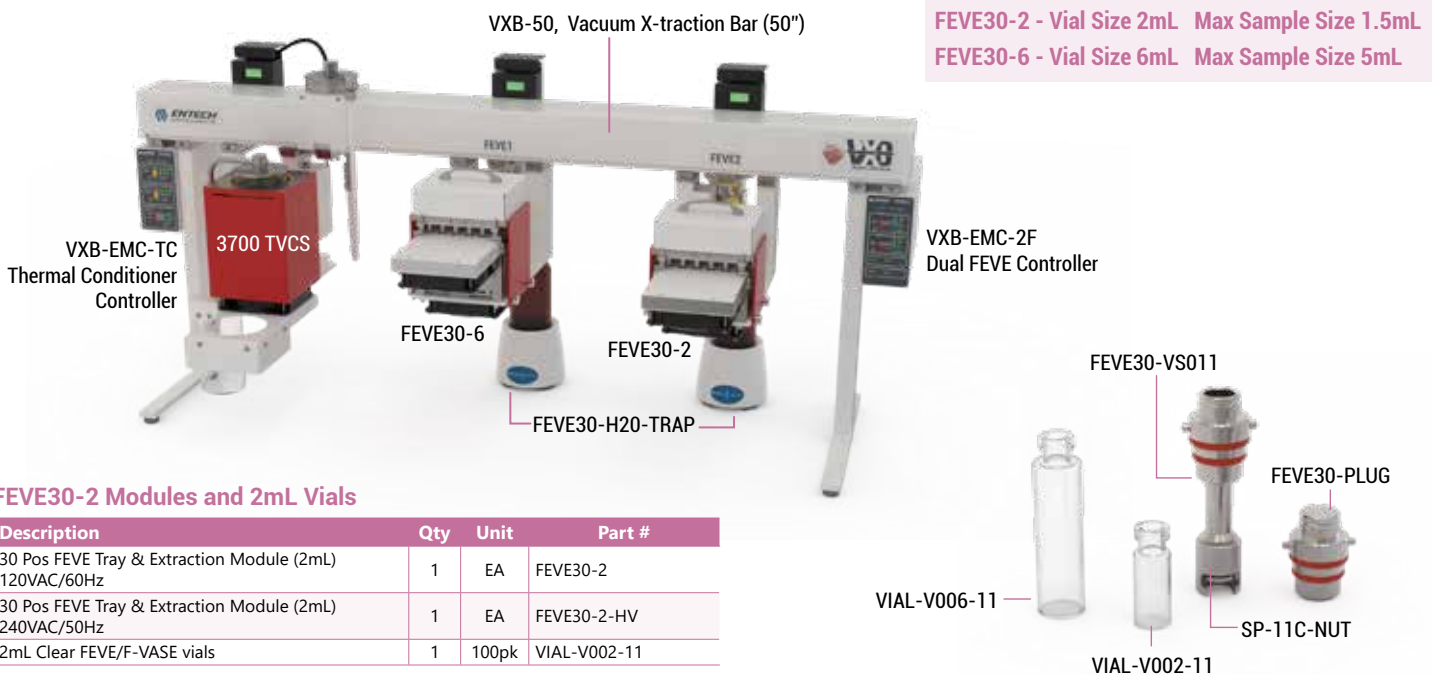
Four FEVE30 Extraction Modules and associated Shuttles utilizing the Vacuum X-traction Bar (VXB) for simultaneous extraction of 120 water samples using less than 1.5 m of bench space.

➡ 30 Sorbent Pen Tray

➡ 30 FEVE Shuttle

FEVE30 utilizing the Vacuum X-traction Bar (VXB)

The Vacuum X-traction Bar (VXB) supports sample extraction onto Sorbent Pens and the cleanup of Sorbent Pens and associated extraction hardware (sleeves, O-rings, etc). The VXB allows extractions to be performed in the sample preparation area, with only the extracts on Sorbent Pens brought into the GCMS laboratory. This is similar to how sample preparation techniques are currently performed, except the Entech vacuum extraction methods are easier, cleaner, and more sensitive, all without the use of hazardous solvents. The VXB comes in 30" and 50" sizes, large enough to support multiple FEVE extraction modules. Other modules may also be connected, such as the 3700 Thermal Vacuum Cleaning System, which is utilized to restore background-free extraction hardware before performing the next set of extractions. The 3700 performs both a quick steam cleaning of the extraction hardware, followed by a higher temperature, higher vacuum dry cleaning to completely remove surface and O-ring residue.



FEVE30-2 - Vial Size 2mL Max Sample Size 1.5mL
FEVE30-6 - Vial Size 6mL Max Sample Size 5mL

FEVE30-2 Modules and 2mL Vials

Description	Qty	Unit	Part #
30 Pos FEVE Tray & Extraction Module (2mL) 120VAC/60Hz	1	EA	FEVE30-2
30 Pos FEVE Tray & Extraction Module (2mL) 240VAC/50Hz	1	EA	FEVE30-2-HV
2mL Clear FEVE/F-VASE vials	1	100pk	VIAL-V002-11

FEVE30-6 Large Volume FEVE Modules and 6mL Vials

Description	Qty	Unit	Part #
30 Pos FEVE Tray & Extraction Module (6mL), 120VAC/60Hz	1	EA	FEVE30-6
30 Pos FEVE Tray & Extraction Module (6mL), 240VAC/50Hz	1	EA	FEVE30-6-HV
6mL Clear FEVE/F-VASE vials	1	100pk	VIAL-V006-11

VXB - Vacuum X-traction Bars

Description	Qty	Unit	Part #
Vacuum X-traction Bar (30" VXB), allows 1-2 modules to be attached simultaneously	1	EA	VXB-30
Vacuum X-traction Bar (50" VXB), allows 3-4 modules to be attached simultaneously	1	EA	VXB-50

FEVE30 Controllers

Description	Qty	Unit	Part #
Dual FEVE30 Controller for FEVE1/FEVE2, 120VAC	1	EA	VXB-EMC-2F-12
Dual FEVE30 Controller for FEVE1/FEVE2, 240VAC	1	EA	VXB-EMC-2F-12-HV
Dual FEVE30 Controller for FEVE3/FEVE4, 120VAC	1	EA	VXB-EMC-2F-34
Dual FEVE30 Controller for FEVE3/FEVE4, 240VAC	1	EA	VXB-EMC-2F-34-HV

Each controller can simultaneously perform extractions on two separate 30-Position FEVE30 Modules.

Vacuum Extraction Vials, Sleeves, Components, Accessories

Description	Qty	Unit	Part #
FEVE30 Vacuum Sleeve for 2/6mL vials	1	EA	FEVE30-VS011
Vacuum Sleeve Nut for 2/6mL vials	1	EA	SP-11C-NUT
30 Position Sorbent Pen Isolation Tray	1	EA	SP-HSP-TRAY30
Vacuum Plugs for unused FEVE30 Positions	1	EA	FEVE30-PLUG
FEVE Shuttle - Sample Mobility & Rail Mount Solution	1	EA	SP-FE-SHUTTLE
Tool for Rev 2 to handle Pen/Vial Load & Extract from FEVE	1	EA	FEVE30-LOAD EXTR-TOOL
Rev 2 Vac Plate/Vial Block Heater Alignment Tool	1	EA	FEVE30-ALIGN-TOOL

Contact Entech for a fully configured FEVE30 bundle based on the matrix to be analyzed (water).

Pumps, Hi-Vac Sensors and Water Management

Description	Qty	Unit	Part #
4-Stage Oilless Diaph. Pump, 3700/FEVE/ MS Rough Pump, 120VAC/60Hz	1	EA	10-20200
4-Stage Oilless Diaph. Pump, 3700/FEVE/ MS Rough Pump, 240VAC/50Hz	1	EA	10-20200-HV
Water Trap	1	EA	FEVE30-H2O-TRAP

Replacement O-rings

Description	Qty	Unit	Part #
Hi Temp Silicone O-rings			
FEVE30 Vacuum Sleeve Upper O-ring, Silicone	1	30pk	FEVE30-OR-TS-30
FEVE30 Vacuum Sleeve Middle O-ring, Silicone	1	30pk	FEVE30-OR-MS-30
FEVE30 Vacuum Sleeve Lower O-ring, Silicone	1	30pk	OR-L011S-30
FKM O-rings			
FEVE30 Vacuum Sleeve Upper FKM O-ring	1	30pk	FEVE30-OR-TF-30
FEVE30 Vacuum Sleeve Middle FKM O-ring	1	30pk	FEVE30-OR-MF-30
FEVE30 Vacuum Sleeve Lower FKM O-ring	1	30pk	OR-L011F-30

FEVE30 (Rev 2) Bundles

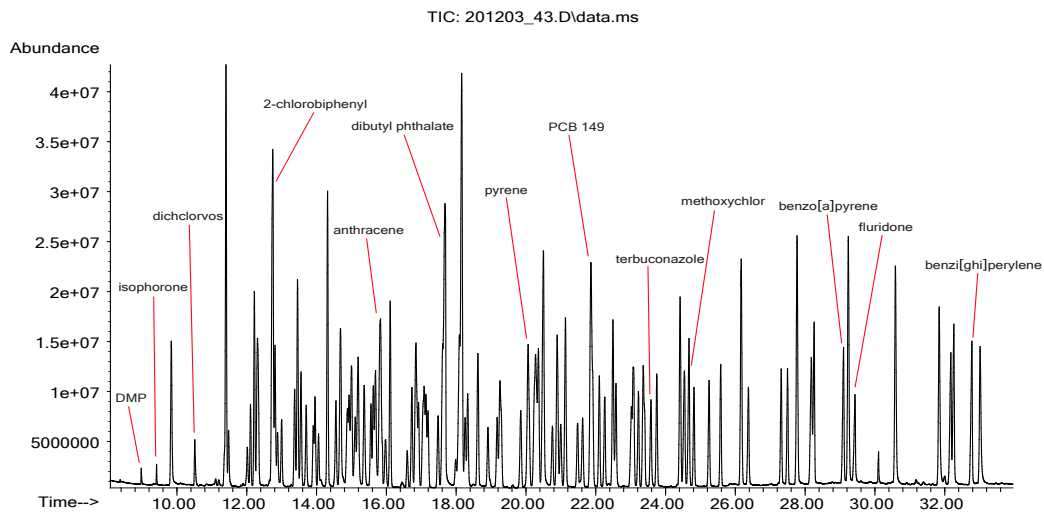
Description	Unit	Part #
FEVE30 (Rev 2) System Bundle (120VAC/60Hz)*	EA	FEVE30-2-B01
30 Pos FEVE Tray & Extraction Module (2mL) 120VAC/60Hz*	EA	FEVE30-2
Dual FEVE30 Controller for FEVE1/FEVE2, 120VAC*	EA	VXB-EMC-2F-12
4-Stage Oilless Diaph. Pump, 3700/FEVE/ MS Rough Pump, 120VAC/60Hz*	EA	10-20200
2mL Clear FEVE/F-VASE vials	100pk	VIAL-V002-11

*Add "-HV" when ordering the 220-240VAC/50Hz model. Order FSP Pens Separately. SP-FSP-PDGB-TNX Recommended for SVOCs in Water. Order the VXB50 to support more than 1 FEVE30 module, or the VXB30 when using only 1 FEVE30.

Typical Water Matrix Extraction Method

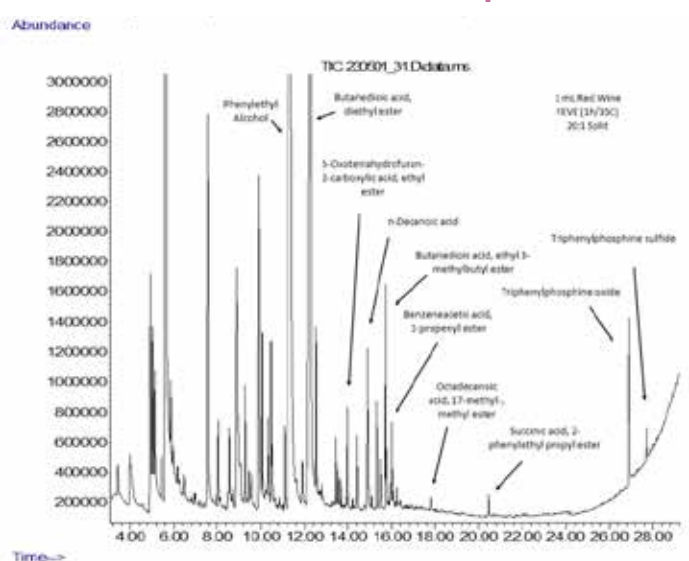
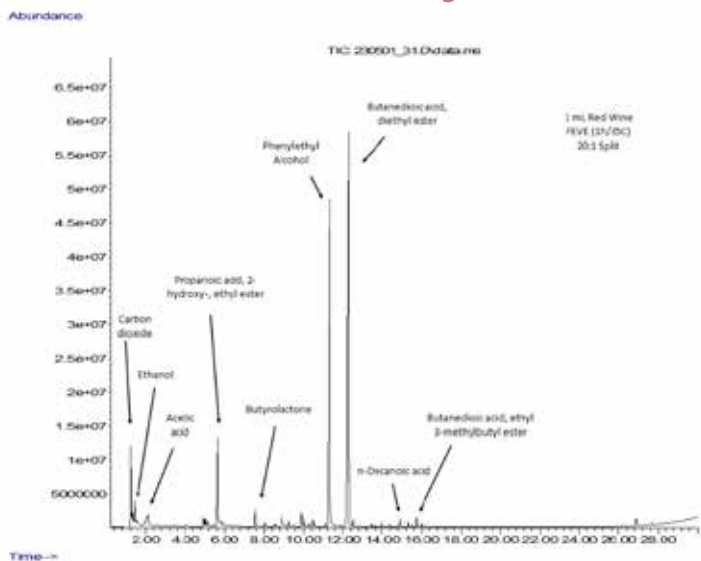
Sample Type	Dynamic Extraction (Matrix Evaporation)	Hi-Vac Dehydration	Preheat
Aqueous	Vial Heater Temperature: 40°C	Vial Heater Temperature: 40°C	Vial Heater Temperature: 200°C
Vacuum Verification	Top Plate Temperature: 80°C	Top Plate Temperature: 80°C	Top Plate Temperature: 50°C
Target Initial Vacuum: 0.50 psia	Cold Trap Re-Evac Freq.: 2.0 min	High Vac Target Vacuum: 1.50 Torr	Enable Pen Cooling Fan: <input checked="" type="checkbox"/>
Wait for Cold Trap: <input checked="" type="checkbox"/> Yes	Solvent Evac 1: 8.00 min	Target Vac Dehydr. Time: 10.0 min	High Temp Diffusive Extraction
Stabilization Period: 0.5 min	Remove1 Min. Press. Incr.: 0.20 psia	Hi-Vac Dehydration Stage 2	Stage 1 Vial Heater: 0°C
Max. Stabilization Pres.: 0.50 psia	Solvent Evac 2: 3.00 min	Vial Heater Temperature: 50°C	Stage 1 Top Plate: 0°C
Vac. Verification Time: 0.5 min	Remove2 Min. Press. Incr.: 0.20 psia	Water Vac Dehydr. Vac: 1.20 Torr	Stage 1 Duration: 0.0 min
Max. Pressure Increase: 0.10 psia	Matrix Evap. Min. Time: 5.0 min	Target Vac Dehydr. Time: 10.0 min	Stage 2 Vial Heater: 200°C
	Use Hi-Vac Sensor: <input checked="" type="checkbox"/> Yes		Stage 2 Top Plate: 50°C
	Water Evac Target 1: 12.00 Torr		Stage 2 Duration: 5.0 min
	Cold Trap Evac Duration 1: 10 sec		Cool Down
	Vial Heater Temperature 2: 50°C		Vial Heater Temperature: 100°C
	Water Evac Target 2: 7.00 Torr		
	Cold Trap Evac Duration 2: 30 sec		

EPA Method 525.3 Standard, 4 PPBw



1mL Red Wine, 1 Hour FEVE, 30° C,
No Final Heating

Chromatogram Blown up 20 times to Reveal
Trace Aroma/Flavor Compounds



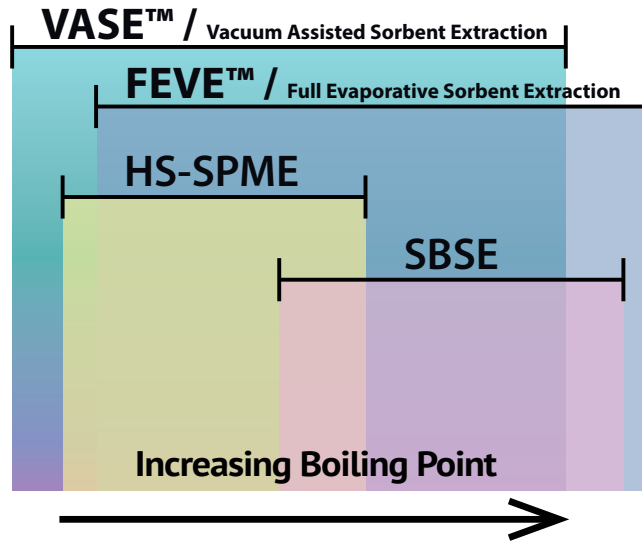
Column not optimized for natural products. Rather than a 100% PDMS phase, recommend an intermediate or polar phase.

FSP- FEVE/Flash-VASE Sorbent Pens

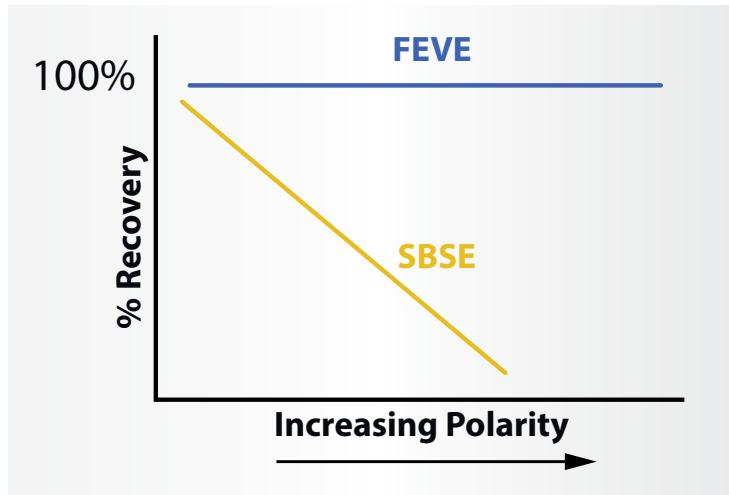
Part #	Adsorbent	Range BP	Label Color	Label	Packing Diagram
SP-FSP-0	Blank / Empty	NA	Yellow		
SP-FSP-PDGB-TNX	PDMS Glass Beads + Tenax®	100°C to >500°C	Red / White		
SP-FSP-TNX	Tenax® TA	100°C to >450°C	White		
SP-FSP-TNX-CPX	Tenax® TA + Carboxen® X	80°C to >450°C	White / Blue		
SP-FSP-TNX-CXN10	Tenax® TA + Carboxen® 1000	-60°C to >450°C	White / Green		
SP-FSP-CUSTOM	End User Defined	NA	Brown		
SP-FSP-525	Method 525 FSP	100°C to >500°C	Red / White		

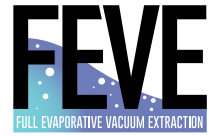
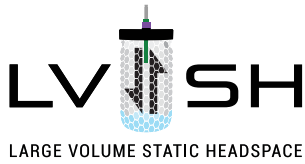
VASE and FEVE (Sorbent Pens) vs HS-SPME and SBSE Recovery Relative to Analyte Volatility

- Using VASE or FEVE, Sorbent Pens can recover compounds over a wider volatility range than either SPME or SBSE.
- Most applications done by either SPME or SBSE can be done more easily and usually with higher sensitivity and accuracy utilizing VASE or FEVE



Typical FEVE vs SBSE (PDMS) Compound Recovery from Water Based on Polarity





Sorbent Pens™ - Achieving the Full Potential of Clean Headspace Extractions in Virtually All Sample Matrices

Learn more about us:



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FEVE30 TID Ver 2.0 –240318 -1.0