FMS
Fluid Management Systems

Fast, Simple Solid Phase Extraction for Drinking and Waste Water Analysis

Agenda

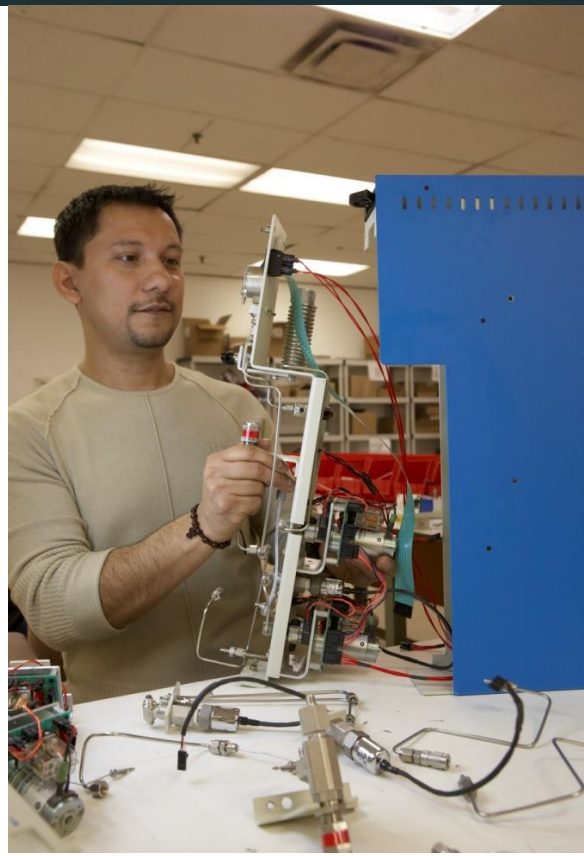
- FMS, Inc. Fluid Management Systems
- Sample Prep vs Analytical Runs in time
- Sample Prep Workflow
- LLE/CLE vs Solid Phase Extraction
- Manual vs Automated SPE
- Semi Automated SPE
- Results

FMS

- **FMS - Fluid Management Systems**
  - **Founded in 1986**
  - **Manufactures Total Solution Sample Preparation and Consumables for GC, GC/MS, LC and LC/MS**

FMS
Fluid Management Systems

Made in the USA



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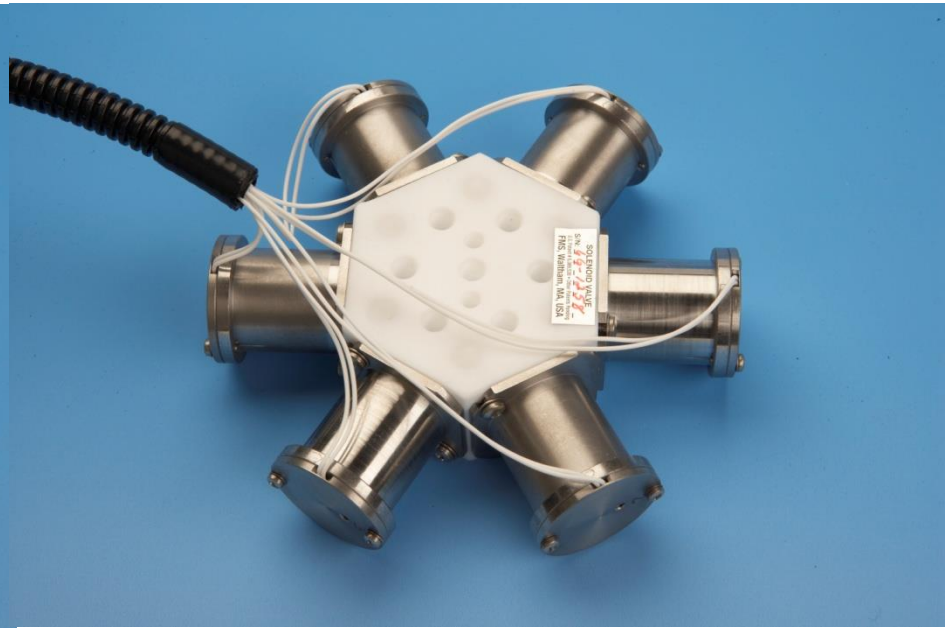
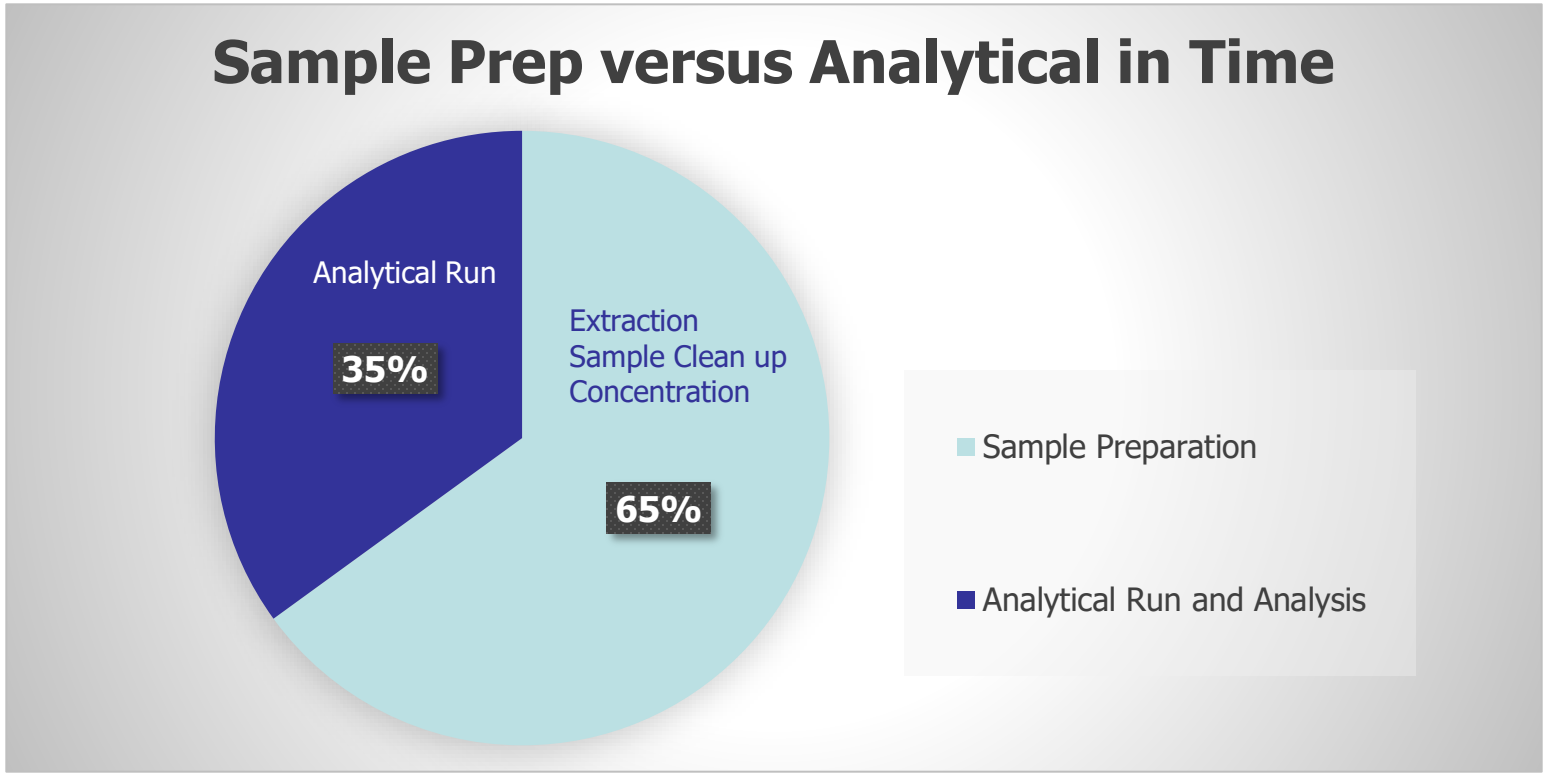


Class 1000 Cleanroom for Consumables Manufacturing

Laboratory Workflow Breakdown



Comparison of LLE/CLE vs. Automated SPE Methods

LLE/CLE	Automated SPE
Open to laboratory background	Closed system
Uses >360mls solvent	Uses <60mls solvent
Shaking / Continuous process	Filtration process
Forms emulsions requiring centrifuging	No emulsions formed
Little Selectivity	Wide Selectivity (sorbent)
Requires water removal	In-line water removal
	Fast and Unattended

Comparison of LLE/CLE vs. Automated SPE Methods

LLE/CLE	Automated SPE
No Separation of waste	Separates Aqueous and Organic Waste
More volume to evaporate	<60mls solvent to evaporate
Massive solvent emission	6 times less solvent emission
CLE high electrical costs	Easily Capture Solvent
Requires lots of solvent for cleaning	Lower solvent costs
	Lower Disposal Costs

Reduced Solvent Usage

Reasons for SPE

- **Reduced solvent**
- **Reduced glassware**
- **Simplified procedures**
- **Automated versus manual protocols = Reproducibility**
- **Increased Sample Throughput**

Determining Factors

- **Ability to load samples by vacuum.**
- **Ability to dry cartridges by both vacuum and positive gas pressure (N2 or CO2).**
- **Easily handle a wide variety of cartridge designs and sizes without cumbersome modifications.**

Comparison of Manual SPE vs. Automated SPE Methods

Manual	Automated SPE
Open to laboratory background	Closed system
Uses >60mls solvent	Uses <60mls solvent
Filtration process	Filtration process
No emulsions formed	No emulsions formed
Wide Selectivity (adsorbent)	Wide Selectivity (adsorbent)
Requires water removal	In-line water removal
Labor intensive requires monitoring	Fast and Unattended

Comparison of Manual SPE vs. Automated SPE Methods

Manual SPE	Automated SPE
Separates Aqueous and Organic Waste	Separates Aqueous and Organic Waste
<60mls solvent evaporate	<60mls solvent to evaporate
Run times are ~ 60 minutes	Run times are ~ 35 minutes or less
Technician Time 60 minutes	Technician time 5minutes
Physical transfer and Concentration steps	Automatic and Direct to Concentration delivery and completion
Concentration steps > 60 minutes	Concentration step 45 minutes ready for injection

Automated Solid Phase Extraction front end for GC/MS and LC/MS

EconoTrace®

TurboTrace®

TurboTrace® ABN

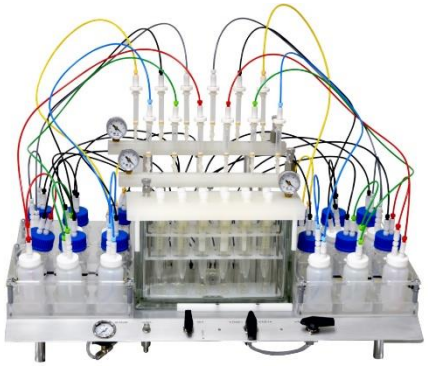
TurboTrace® PFC

NanoTrace®

Semi-Automated Solid Phase Extraction front end for GC/MS and LC/MS

Fluid Management Systems

EZSPE



EZPFC

Direct to Vial Concentration

Direct to Vial Concentration

SuperVap – Concentration System

- 6 Position 250ml Vessel
- 12 Position 50ml Vessel
- 12 Position 20,40,60 ml vial
- 24 Position 2ml, 4 ml vial
- 24 Position PFC 15ml Conical tube

Sample Analysis Work Flow

Automated Sample Prep Time

= 80 Minutes

Solid Phase Extraction

35 Minutes

Concentration

45 Minutes

Semi Automated Sample Prep Time

= 80 Minutes

Solid Phase Extraction

35 Minutes

Concentration

45 Minutes

Objective for Semi Automation

- **Use as many features from the FMS Automated systems and implement them into a Semi automated platform**
- **Develop as many SPE procedures for the testing lab using a single extraction platform.**
- **Minimize manual steps to lessen error and maximize limited man hours**

Goal

- **Self Installable**
  - Unpacking and Installation/training video
- **Easy to Operate**
  - No Computers or Electronics to fail or maintain
- **Semi - Automated**
  - Hyphenates the entire Solid Phase Extraction Process – Extraction, Bottle Rinse, Inline Drying and Optional Direct to GC Vial Concentration
- **Fast**
  - The fastest sample processing available for SPE
  - Run up to six samples simultaneously
  - Vacuum for fast loading of large volume samples
  - Unattended Sample loading walkaway time
- **Closed system**
  - Eliminate potential outside contamination

Goal

- **Efficient**
  - Uses all SPE cartridge sizes
  - Dedicated manifold for cartridge conditioning and sample loading
  - Dedicated manifold for extraction and extracts
  - Separates Organic from Aqueous waste
  - Vacuum cartridge drying, Nitrogen cartridge drying or combined
  - Automated Bottle Rinse and Elution
  - Inline Extract Drying
  - Small number of components to clean

- **Low to No Capital Expense**
  - Purchase an FMS Cartridge Contract
  - receive an EZSpe at No Charge

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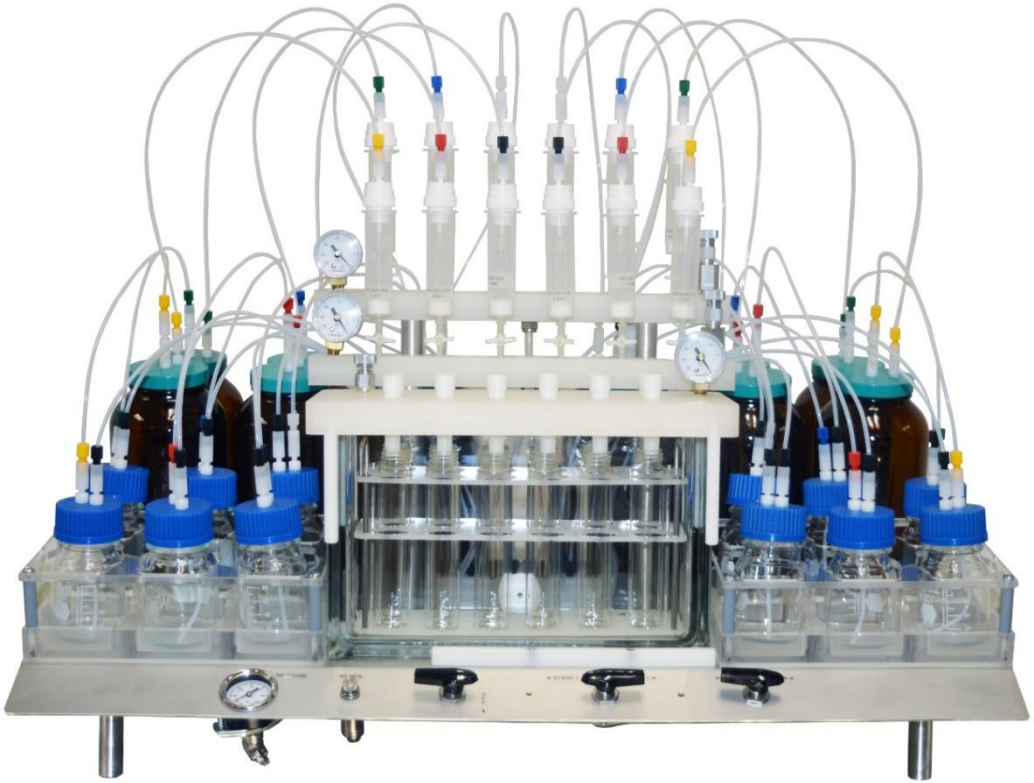
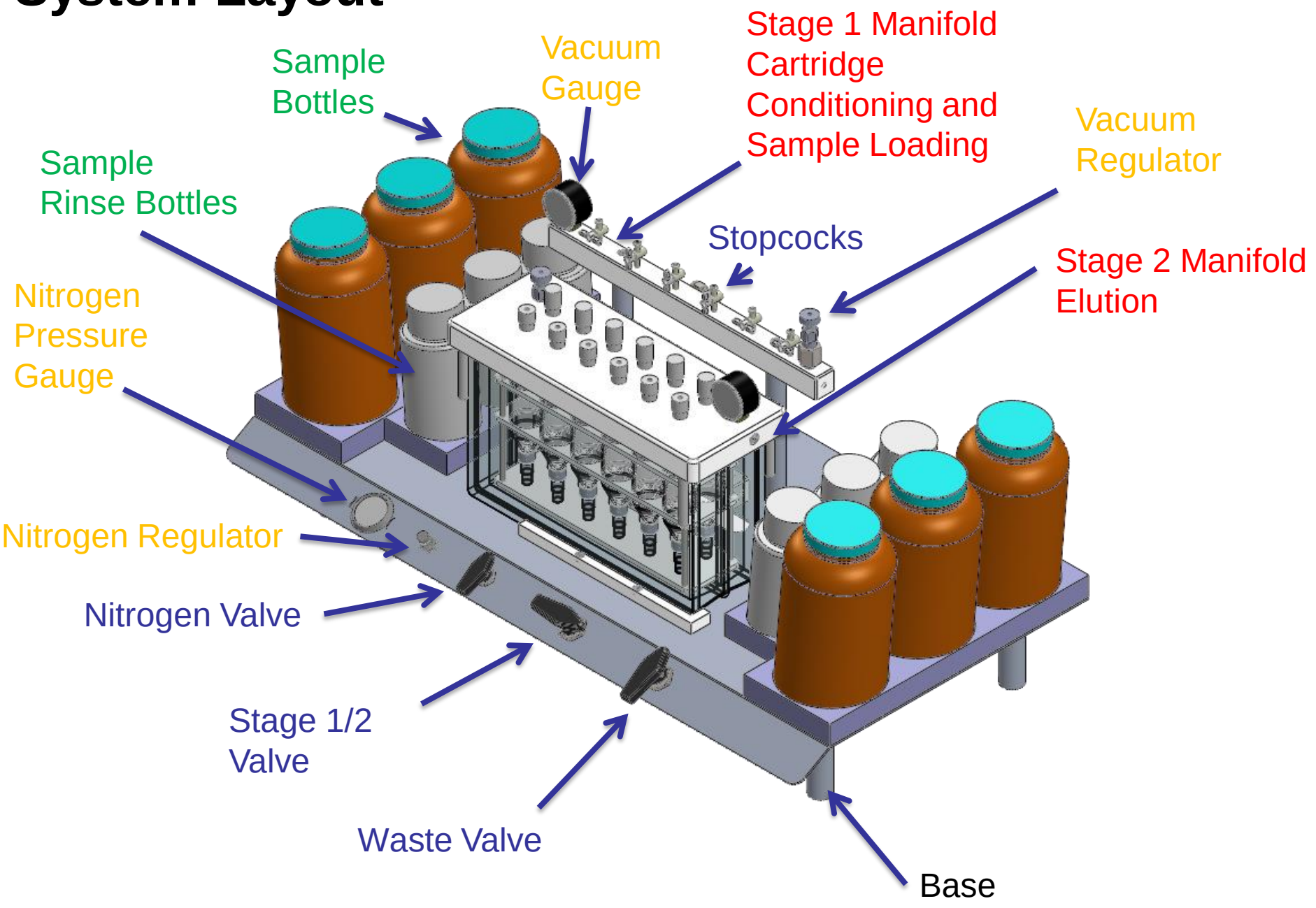
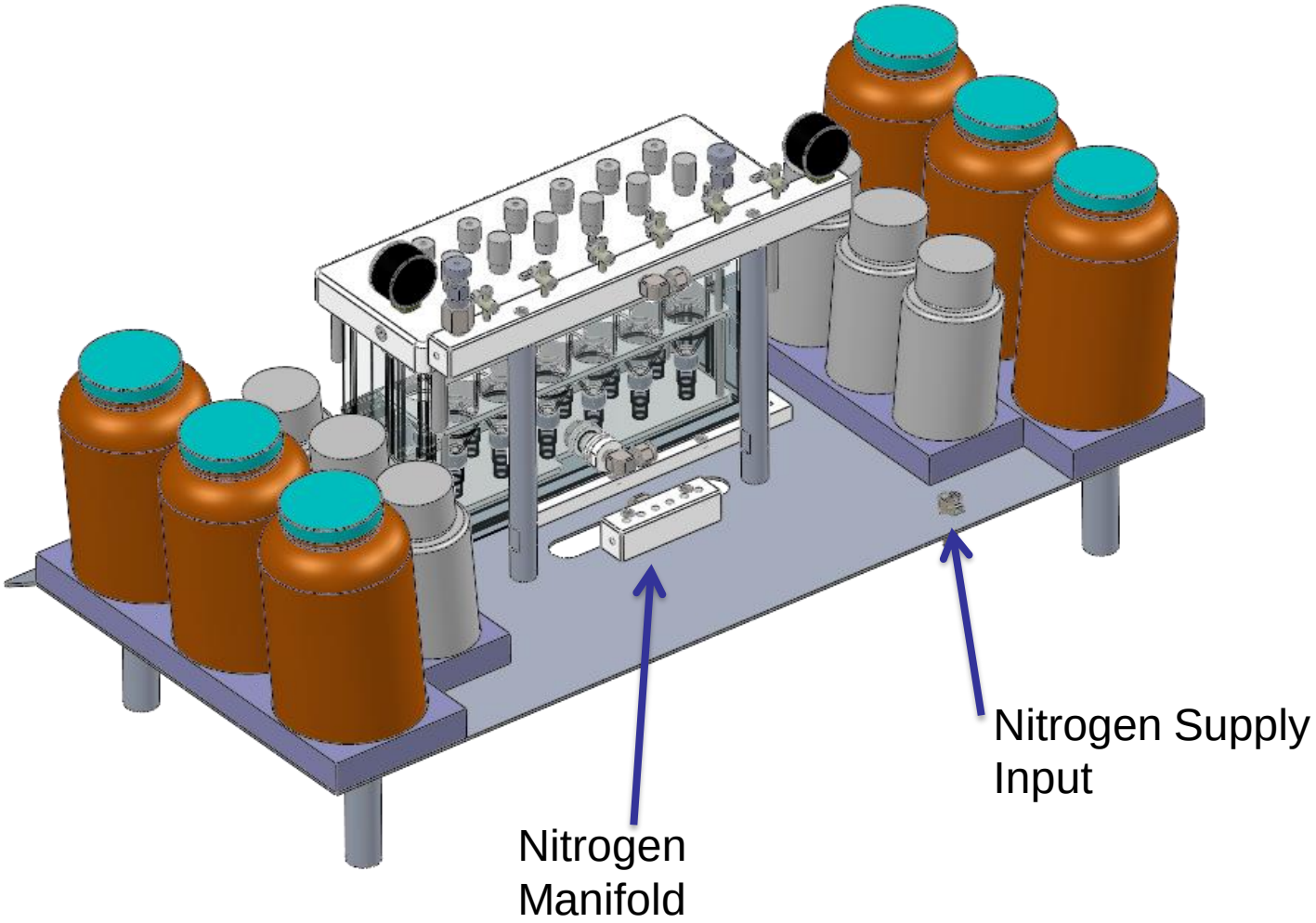
EZSpe®



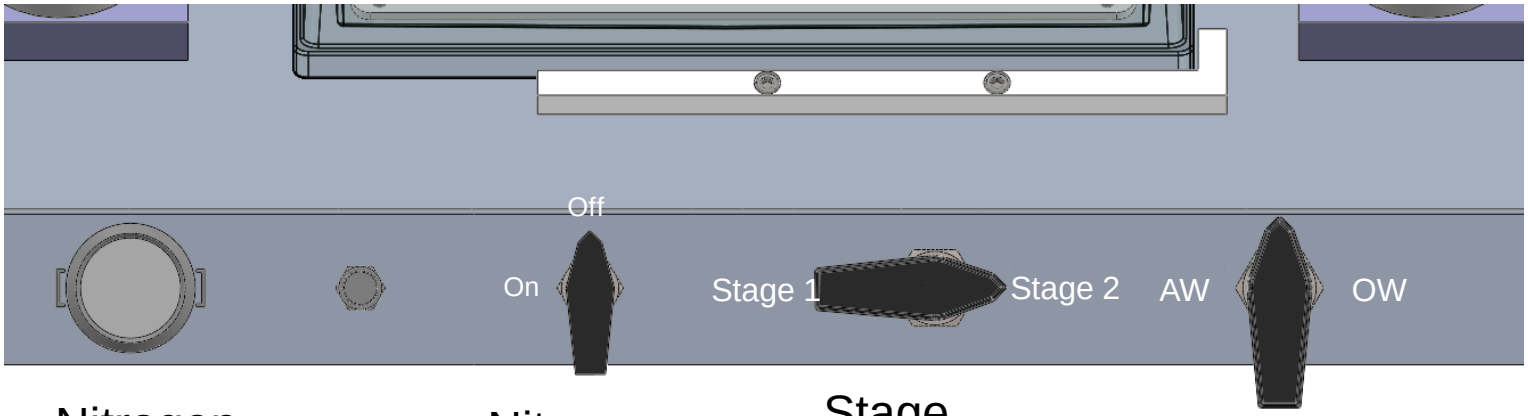
EZSpe 12 sample

System Layout




Nitrogen Supply Input
Nitrogen Manifold

Control Valve Layout



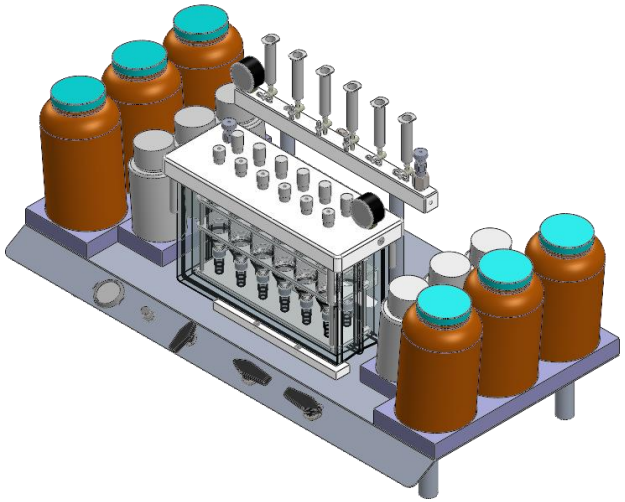
Nitrogen Gauge

Nitrogen Valve

Stage 1/2 Valve

Waste Valve

Cartridge Conditioning (Stage 1, Organic Waste)

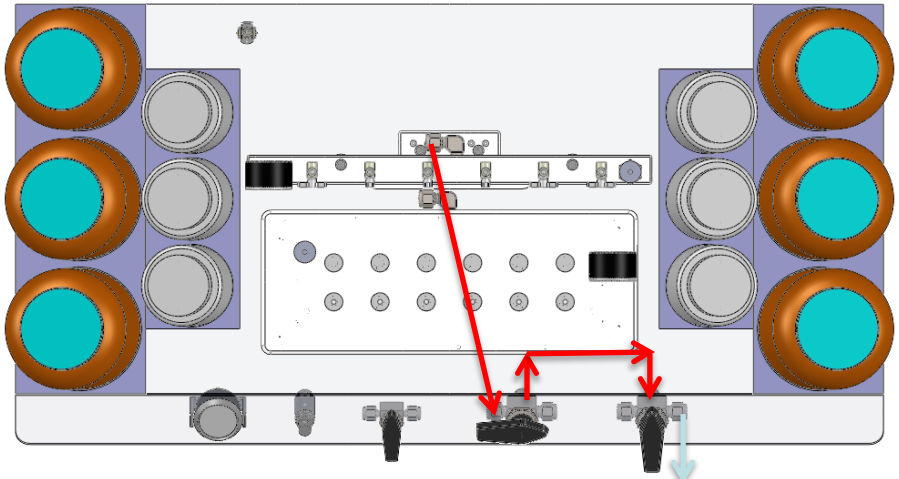


Nitrogen Valve

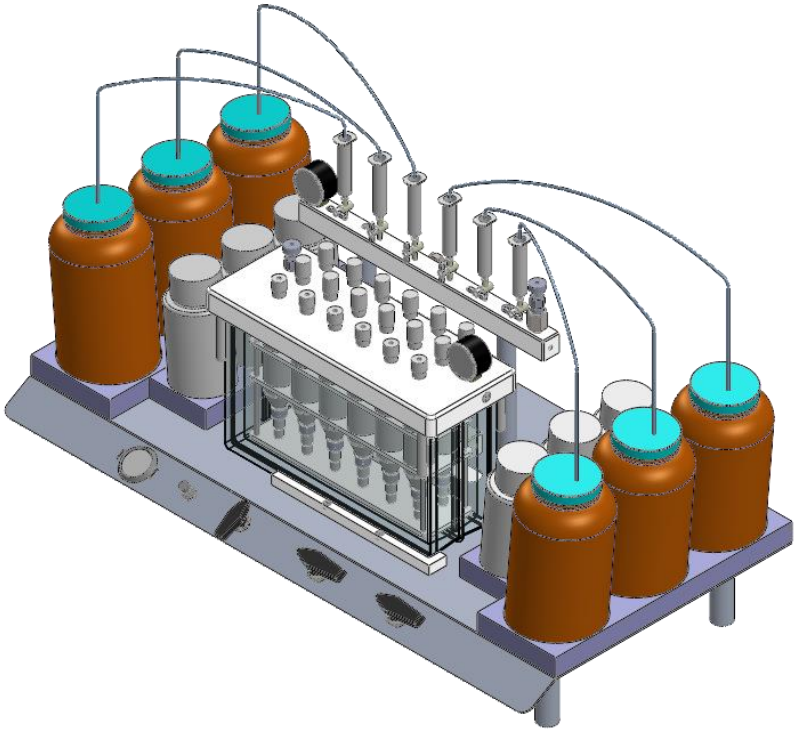
Stage 1/2 Valve

Waste Valve

Flow Path



Sample Loading (Stage 1, Aqueous Waste)

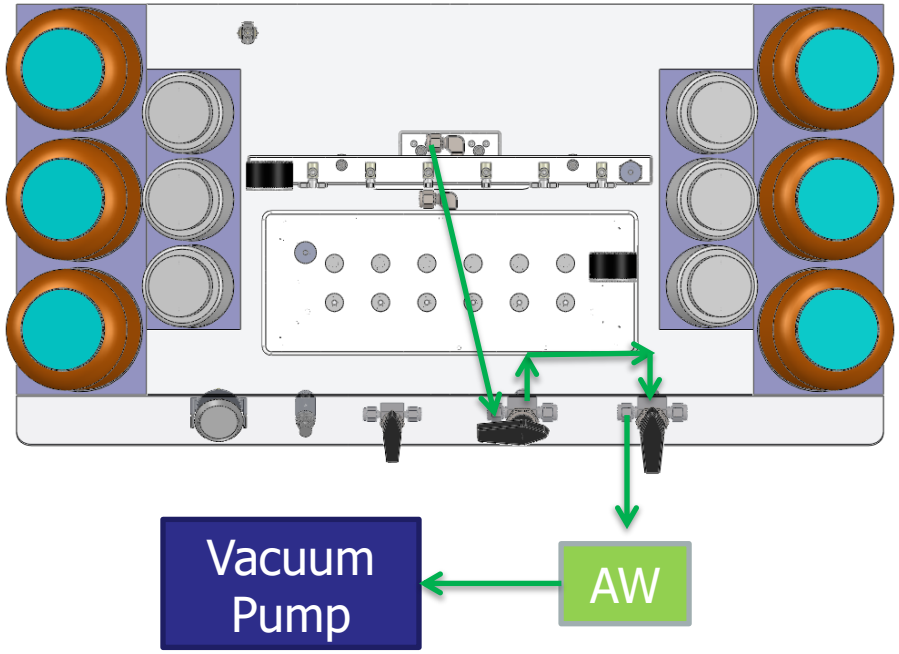


Flow Path

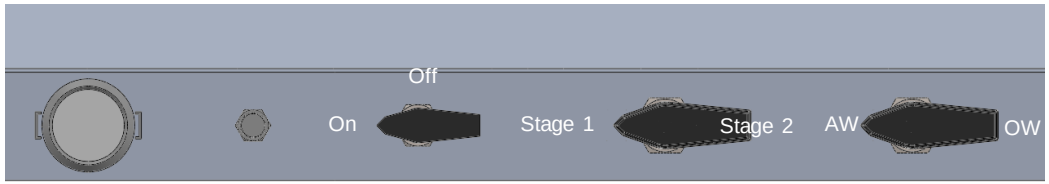
Nitrogen Valve

Stage 1/2 Valve

Waste Valve



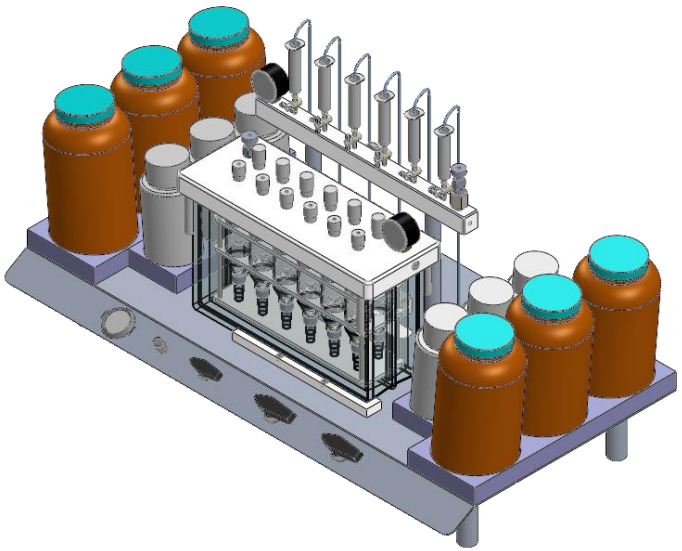
Cartridge Drying- Nitrogen/Vacuum



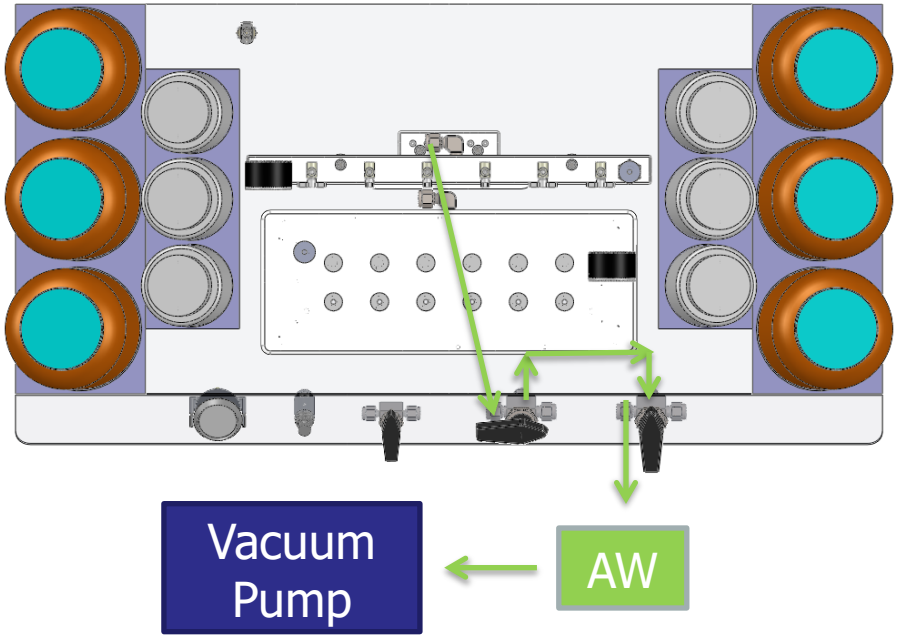
Nitrogen Valve

Stage 1/2 Valve

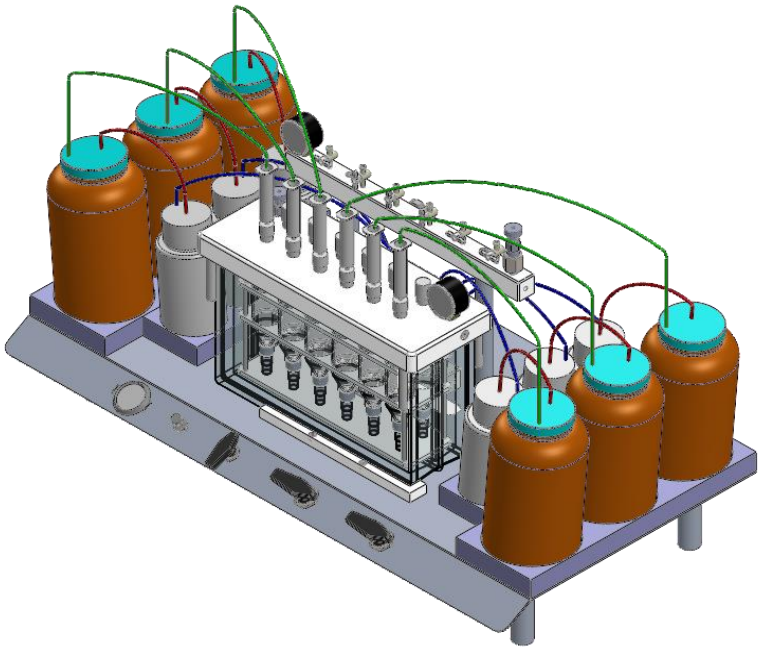
Waste Valve

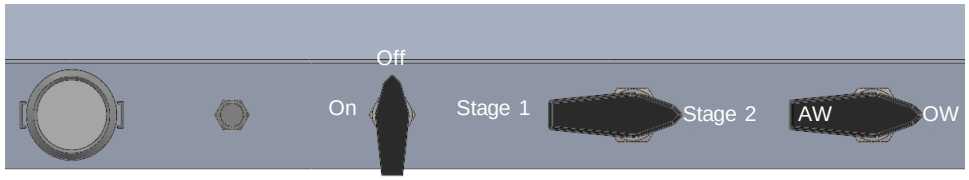


Flow Path



Sample Elution (Stage 2)

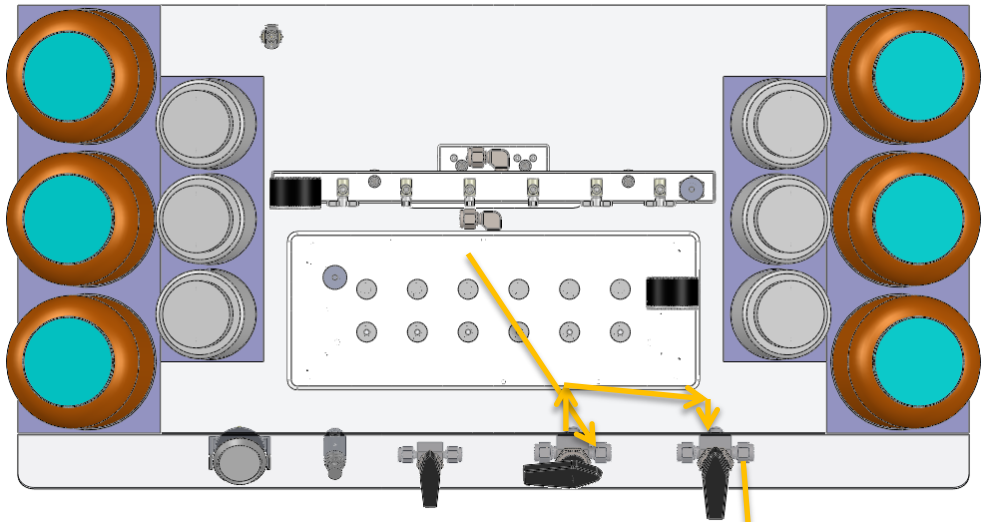




Nitrogen Valve

Stage 1/2 Valve

Waste Valve



Flow Path

Vacuum Pump

OW

Drinking Water Methods

- EPA 507
- EPA 508.1
- EPA 513
- EPA 515.2
- EPA 521
- EPA 522
- EPA 525.3
- EPA 527
- EPA 529
- 537.1
- EPA 548.1
- EPA 550.1
- EPA 552.1

12 position evaporator 50 mLs

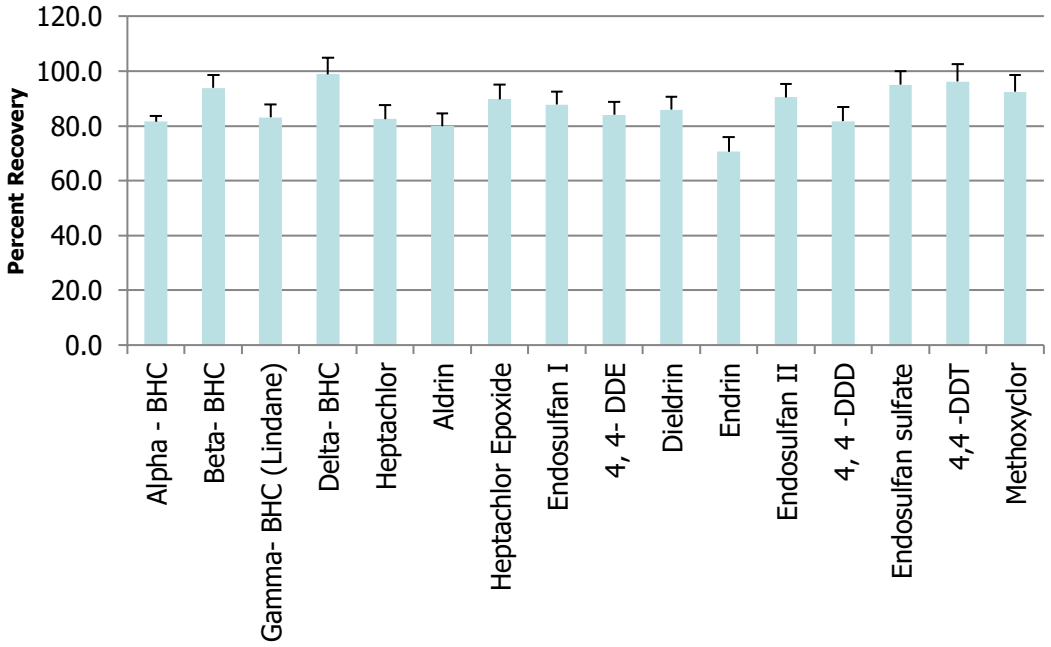
SuperVap Features

- **Self Installable**
  - **Video unpacking, installation and training video**
- **Preprogrammed with most common temperature settings**
- **6 (250mL) and 12 (50mL) position models for extractions, direct-to-vial connections**
- **Dry bath heating element**
- **Independent secondary heater for extract nipple (can be disabled)**
- **Sensor controlled**
- **Savable temperature log capability.**

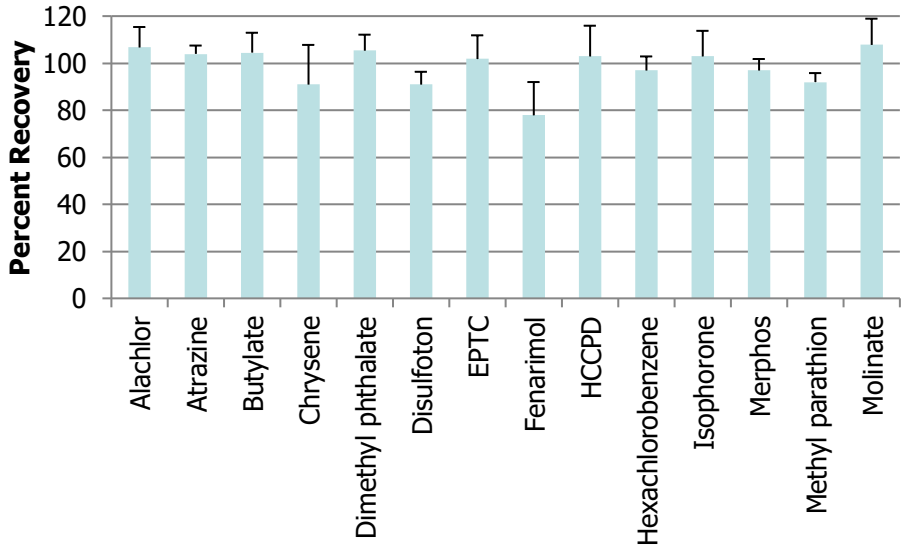
SuperVap 525.3 Method

- Temperature Program 45°C
- Samples reduced to 1 mL under nitrogen flow
- Samples analyzed in 1 mL DCM
- Semi-Volatiles analyzed with low resolution GC/MS (full scan)

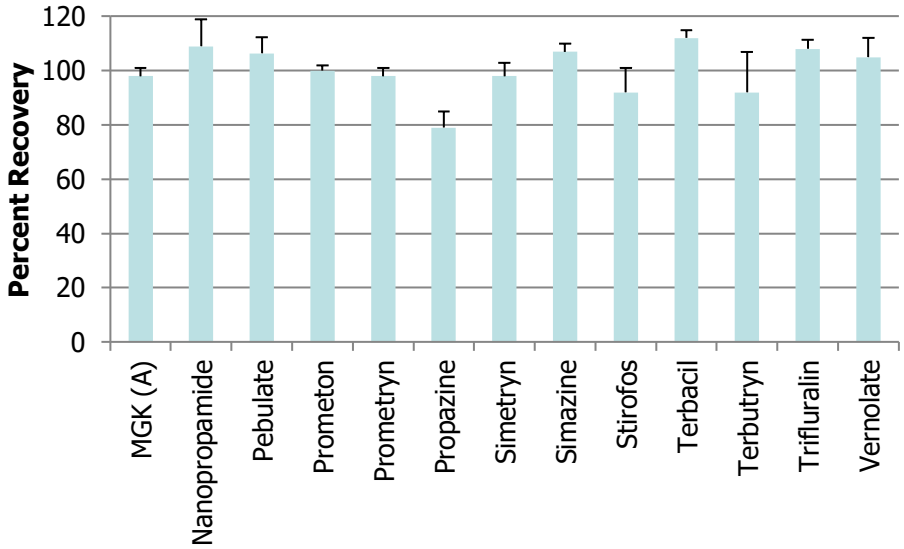
525.3 OCPs (Drinking Water)



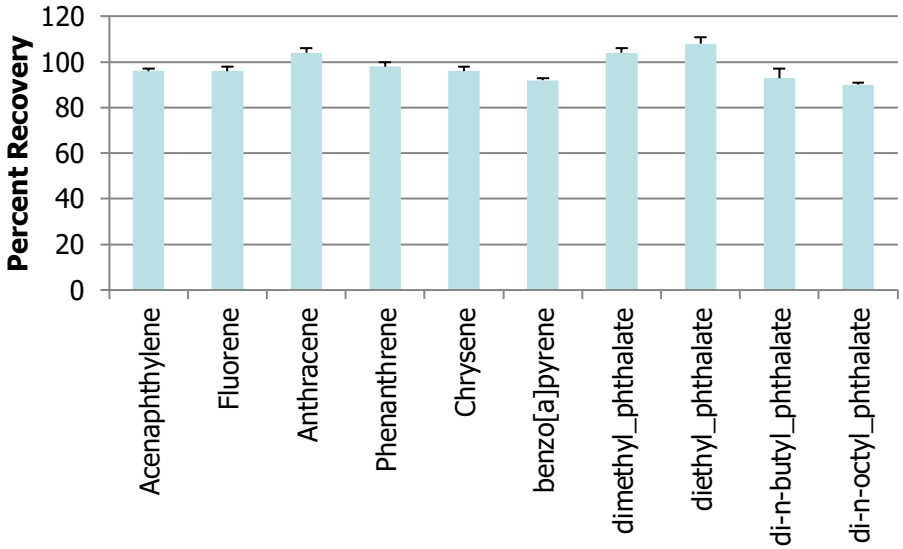
525.3 SVOCs (Drinking Water, 1)



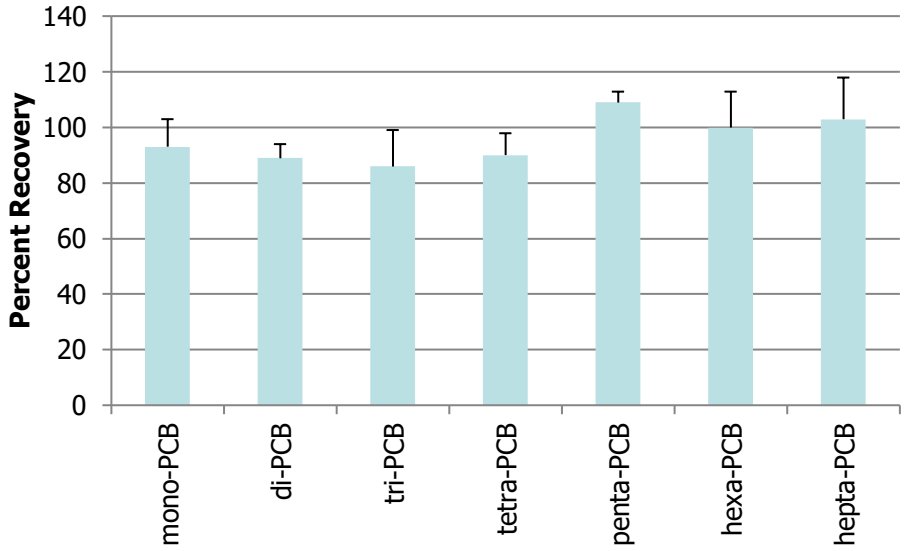
525.3 SVOCs (Drinking Water, 2)



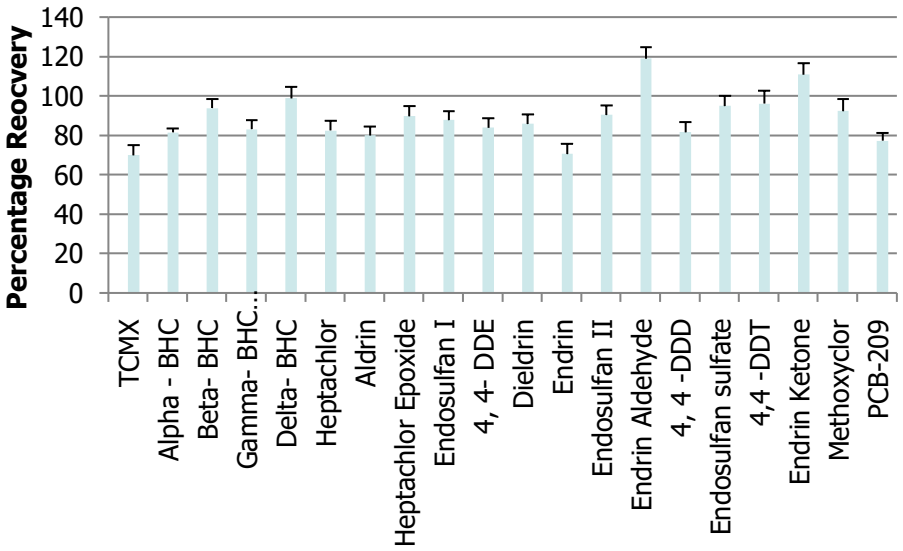
525.3 PAHs and phthalates (Drinking Water)



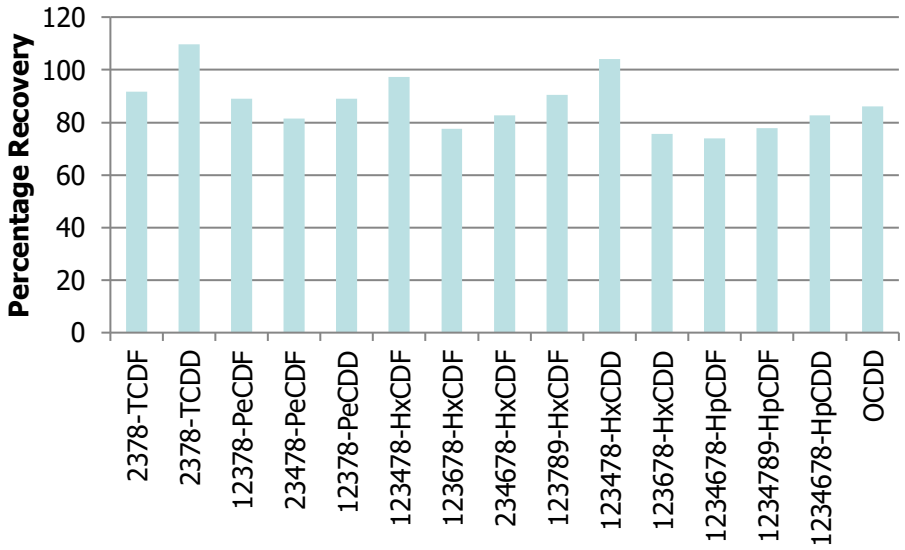
525.3 PCBs (Drinking Water)



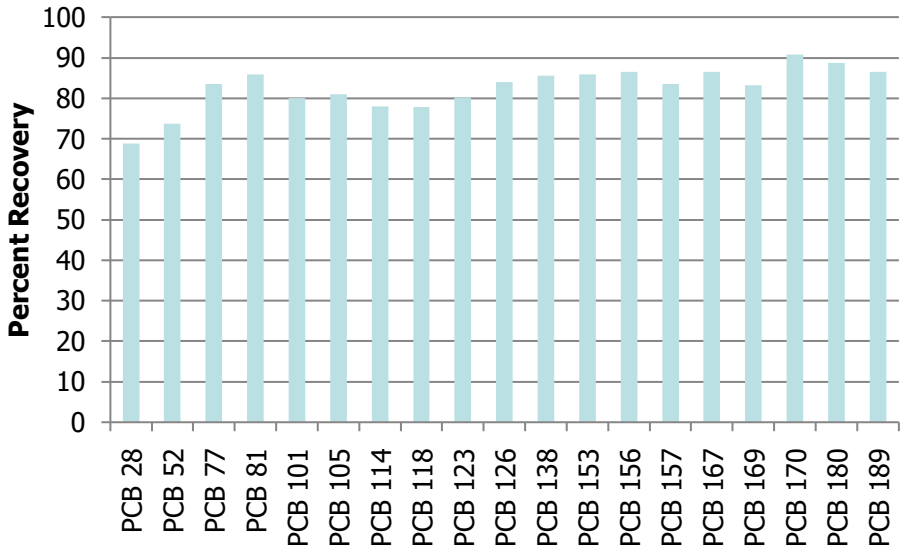
EPA 508 OCPs on EZSpe



Dioxins on EZSpe



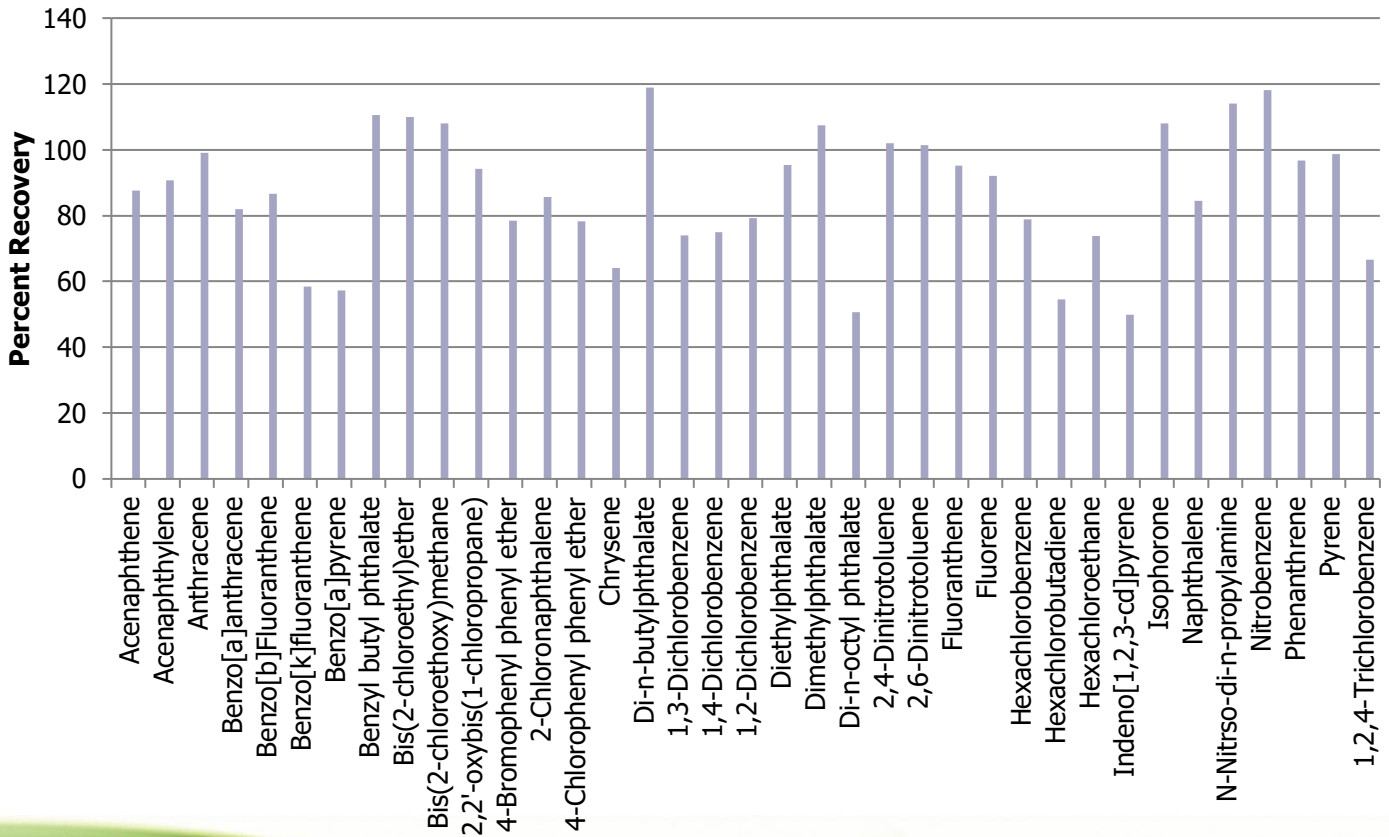
PCBs on EZSpe



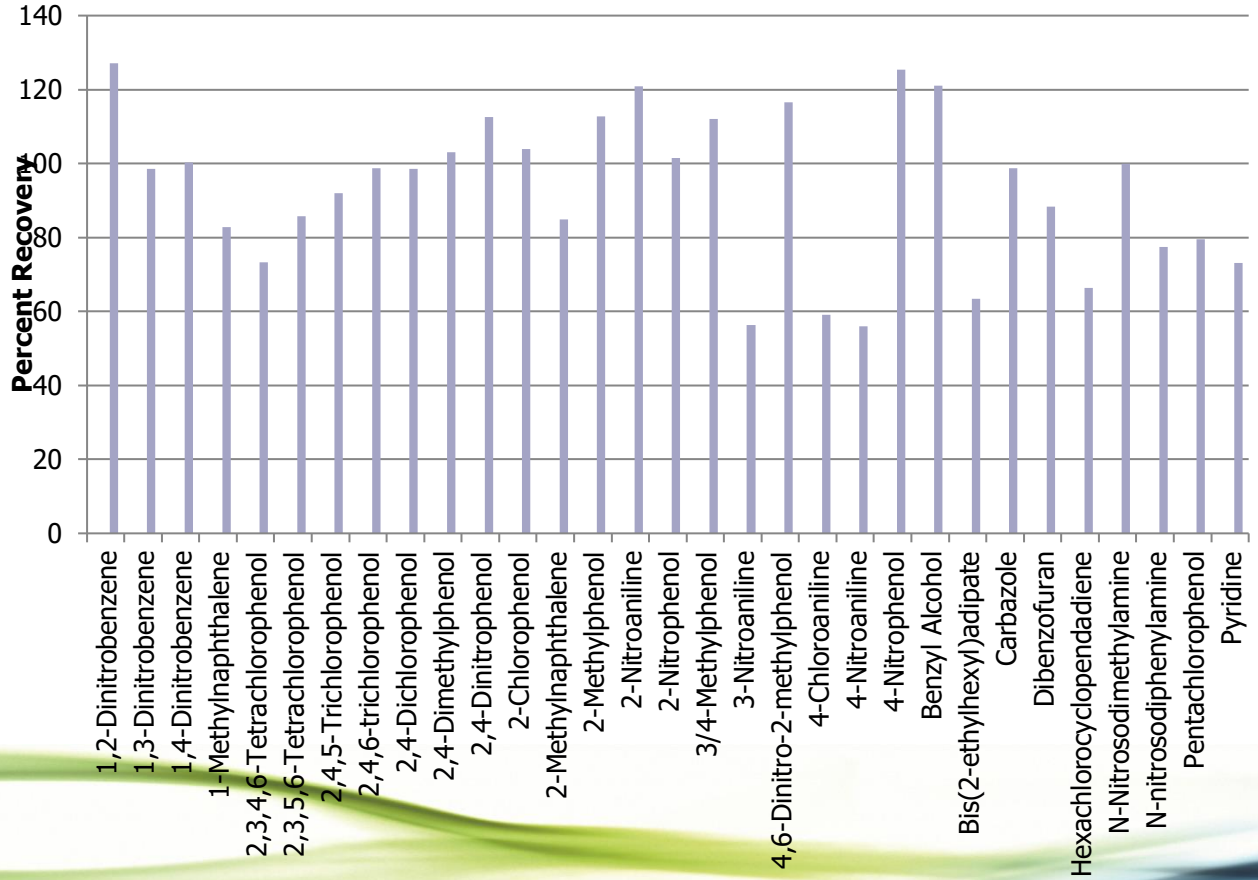
Waste Water Methods

- EPA 608
- EPA 625.1
- EPA 1694
- EPA 1664
- EPA 1613
- EPA 1614
- EPA 8081
- EPA 8082
- EPA 8151
- EPA 8141
- Epa 8290
- EPA 8310
- EPA 8330

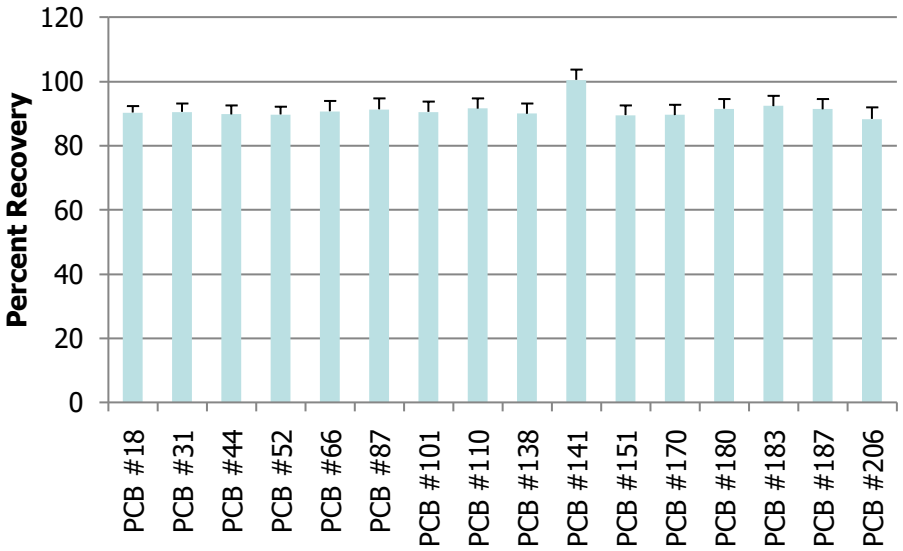
EPA Method 625/8270 (1)



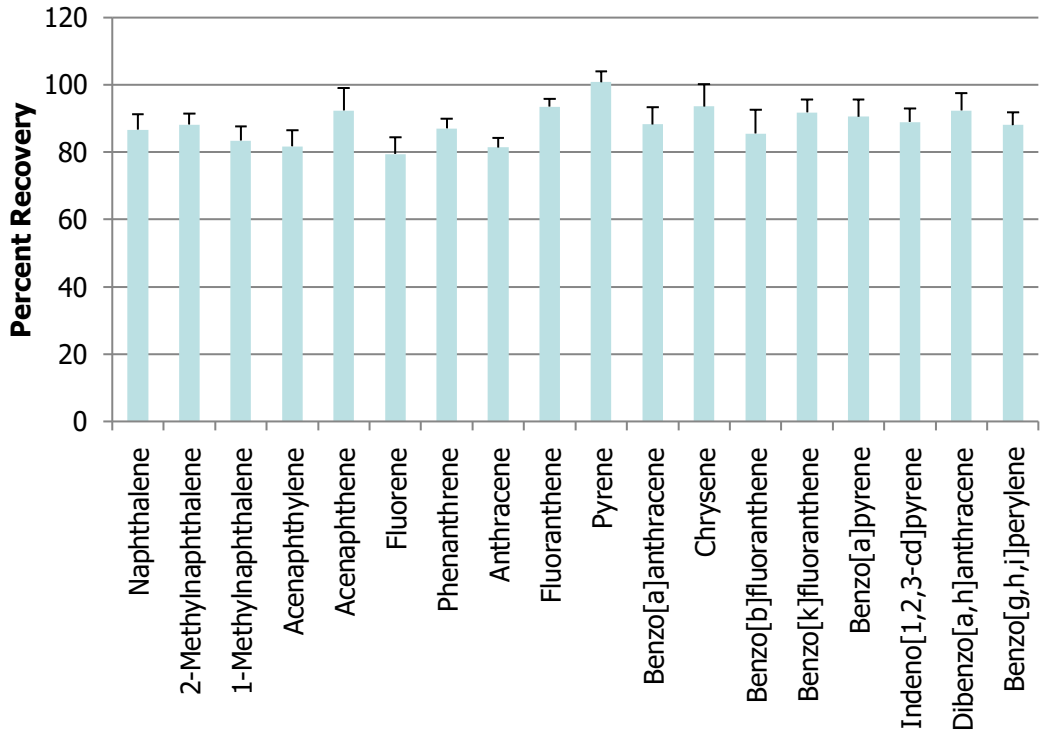
EPA Method 625/8270 (2)



PCBs in Water



PAHs in Water



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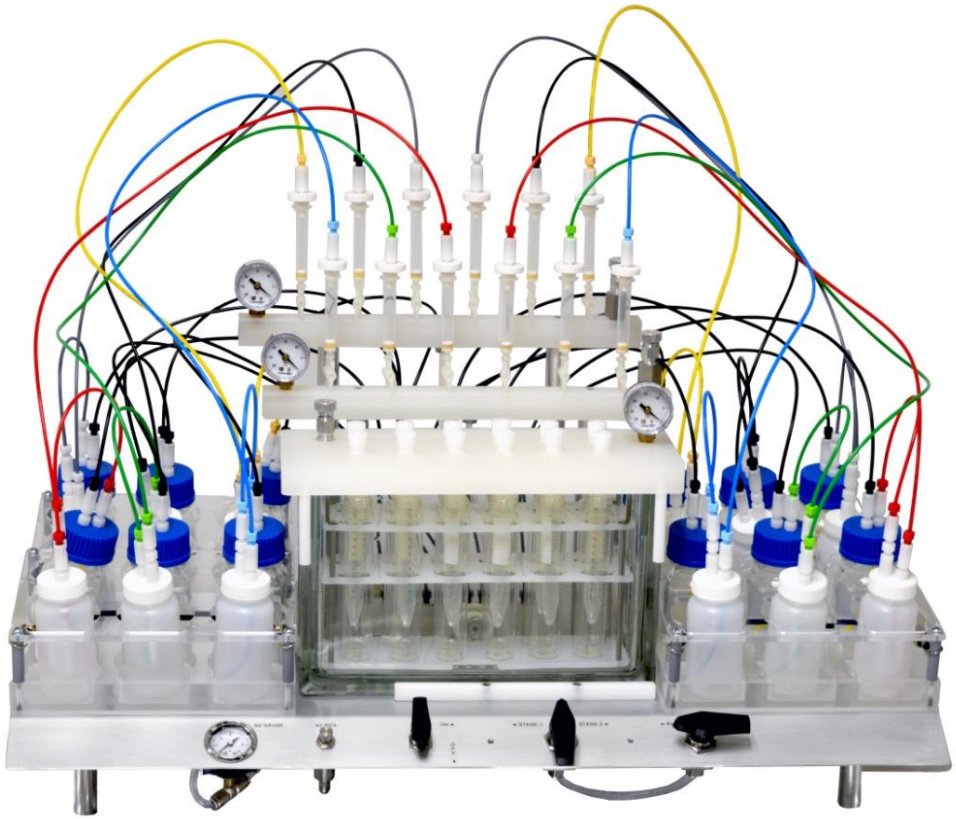
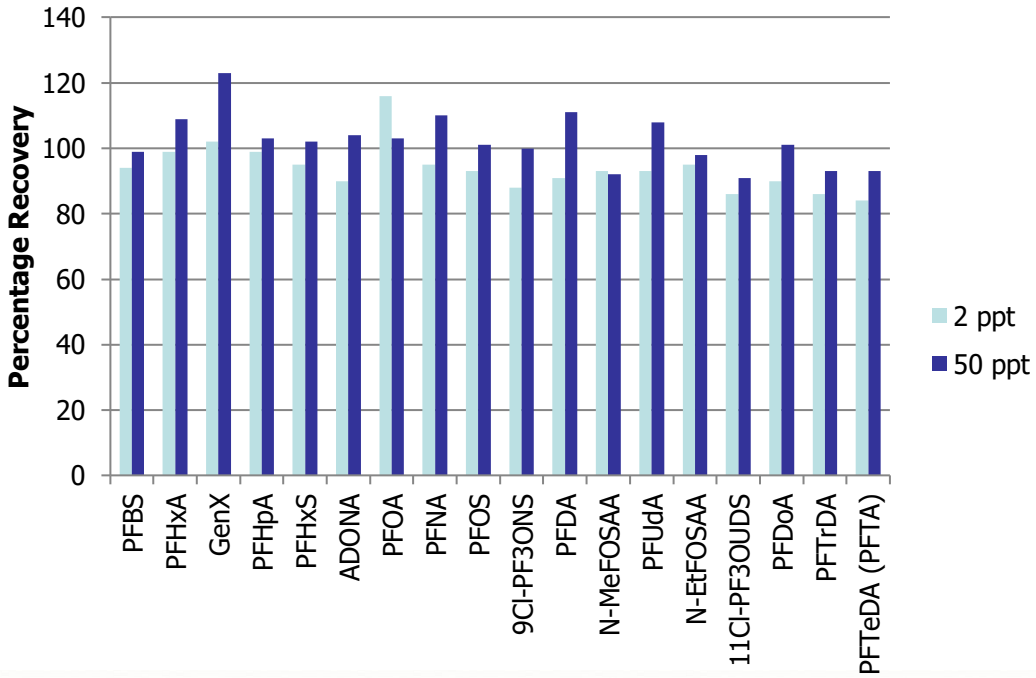
EZPFC®

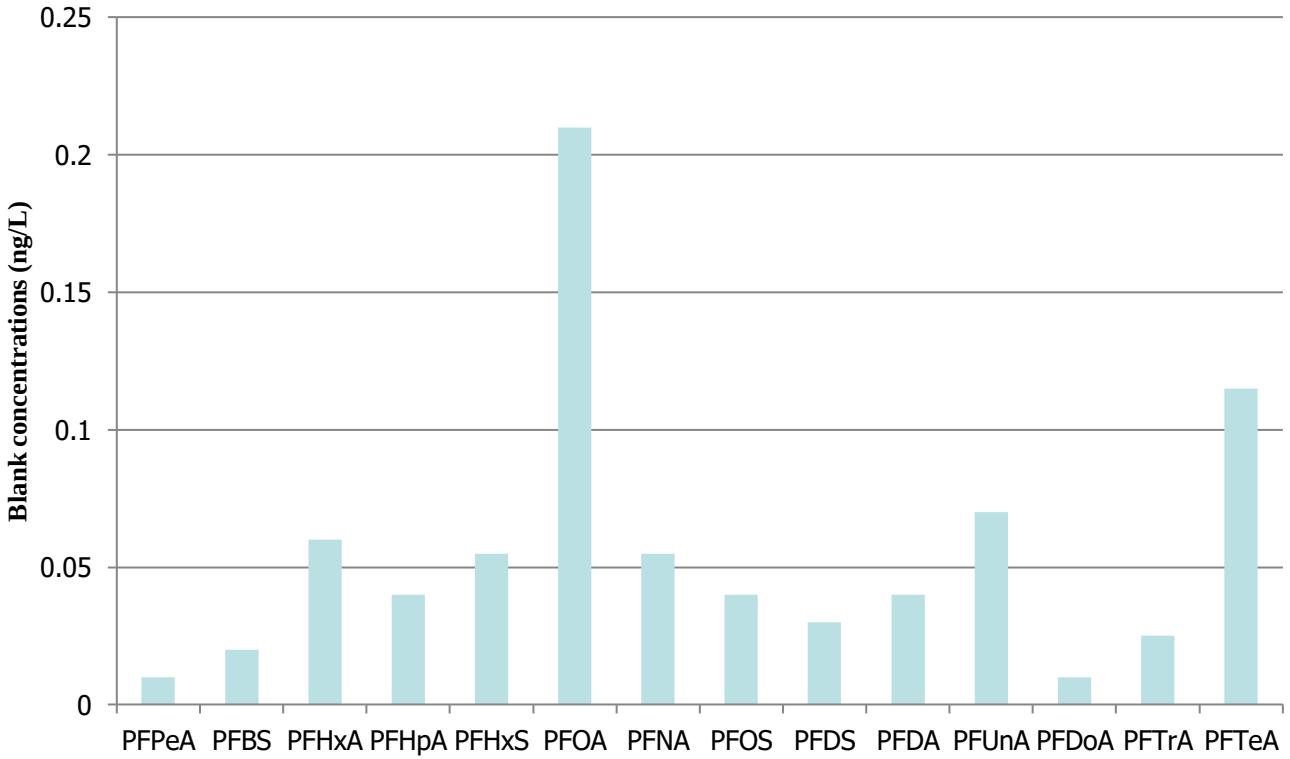


EZPFC 12 Sample System

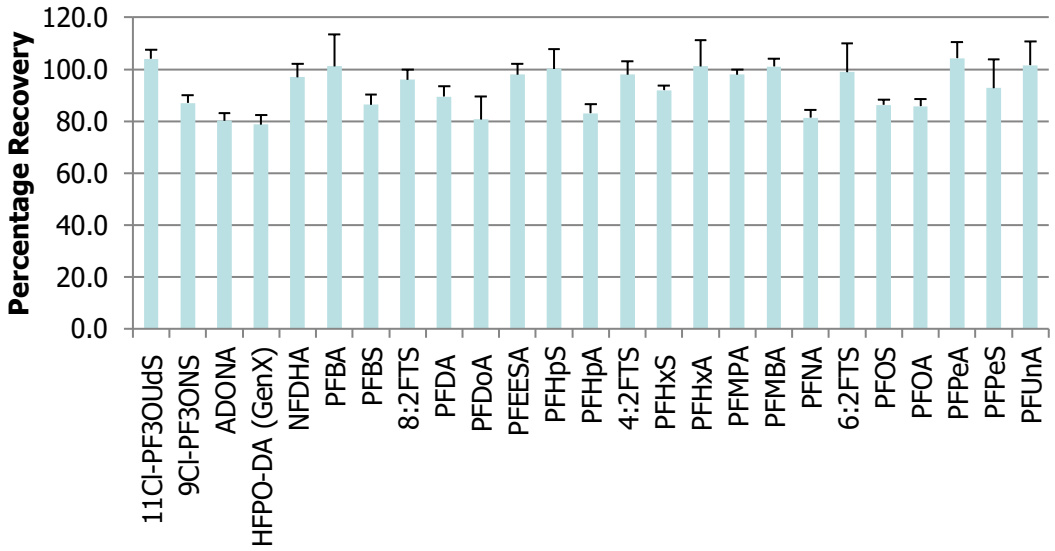
EPA 537.1


Percentage Recovery
140
120
100
80
60
40
20
0
PFBS
PFHxA
GenX
PFHpA
PFHxS
ADONA
PFOA
PFNA
PFOS
9Cl-PF3ONS
PFDA
N-MeFOSAA
PFUdA
N-EtFOSAA
11Cl-PF3OUDS
PFDoA
PFTrDA
PFTeDA (PFTA)
2 ppt
50 ppt

PFAS Background



EPA 533


Percentage Recovery
120.0
100.0
80.0
60.0
40.0
20.0
0.0
11Cl-PF3OUdS
9Cl-PF3ONS
ADONA
HFPO-DA (GenX)
NFDHA
PFBA
PFBS
8:2FTS
PFDA
PFDoA
PFEESA
PFHpS
PFHpA
4:2FTS
PFHxS
PFHxA
PFMPA
PFMBA
PFNA
6:2FTS
PFOS
PFOA
PFPeA
PFPeS
PFUnA

Semi-Automated SPE in Summary

- **EZSpe and SuperVap systems are easy to use and install**
  - **Complete Water Sample Prep Workflow**
- **Low cost, High throughput, Low maintenance solution**
- **EZSpe Extractions and Concentration is a very green technique**
  - **Reduces Solvent Use**
  - **Reduces Solvent Disposal Costs**
  - **Reduces Solvent emissions**

Summation

- **FMS semi-automated SPE and SuperVap systems deliver consistent, reproducible results**
- **Handles a wide range of Sample sizes and matrix types**
- **Uses all SPE Cartridge and Column sizes**
- **Comply with existing methods that require vacuum, positive pressure and precise delivery of sample and solvents**

Summation

- **Solid Phase Extraction is a well accepted technology**
- **New Solid Phase Extraction Chemistries and Sorbents are being developed**
- **Drinking Water and Waste Water Extractions**
  - **625/8270**
  - **608**
- **EZPFC**
  - **Designed for Semi-Automated PFAS Extractions**
  - **SuperVapPFC Concentrator for 24 samples**
- **Capable of performing in line extract drying and/or Cartridge extract clean-ups**

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Questions?