HALO®

PFAS TESTING SOLUTIONS

C18 | PCS PhHx | DELAY

HALO® PFAS COLUMNS

Designed for separation of novel and legacy short chain and long chain PFAS compounds containing branched and linear isomers, along with EPA methodology requirements in mind, HALO® PFAS offers a holistic solution. With both a PFAS specific delay column optimized to prevent background PFAS contamination from interfering with the sample results and an analytical column for PFAS sample separation and detection, the HALO® PFAS solution delivers excellent selectivity, peak shape and necessary retention to perform fast, high resolution separations in EPA methods 1633, 537.1, 533, 8327 and emerging ultra short chain testing.

The HALO® PFAS solution is different from other PFAS column offerings in that it is quality assured for PFAS analysis providing confidence it will meet application demands.

APPLICATIONS

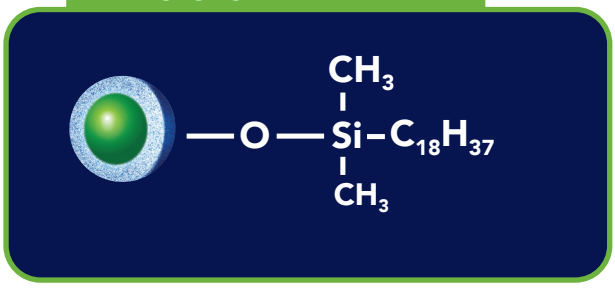
- EPA 533
- EPA 537.1
- EPA 8327
- EPA 1633
- Emerging short and ultra short PFAS compounds

FEATURES

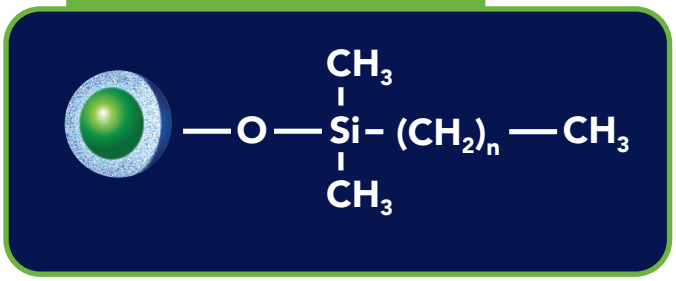
- Application-assured through method qualified lot analysis
- Optimal 2 µm and 2.7 µm SPP for rugged, reliable performance delivering high efficiency, low back pressure separations
- Endcapped alkyl phases for high sensitivity (no bleed) LCMS analysis
- Pressure limit:
  - 2.7 µm 600 bar/9000 psi
  - 2 µm 1000 bar/14,500 psi

LONG AND SHORT CHAIN

PFAS C18

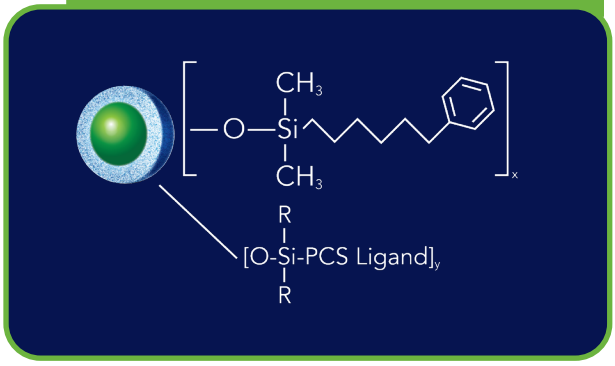


PFAS DELAY



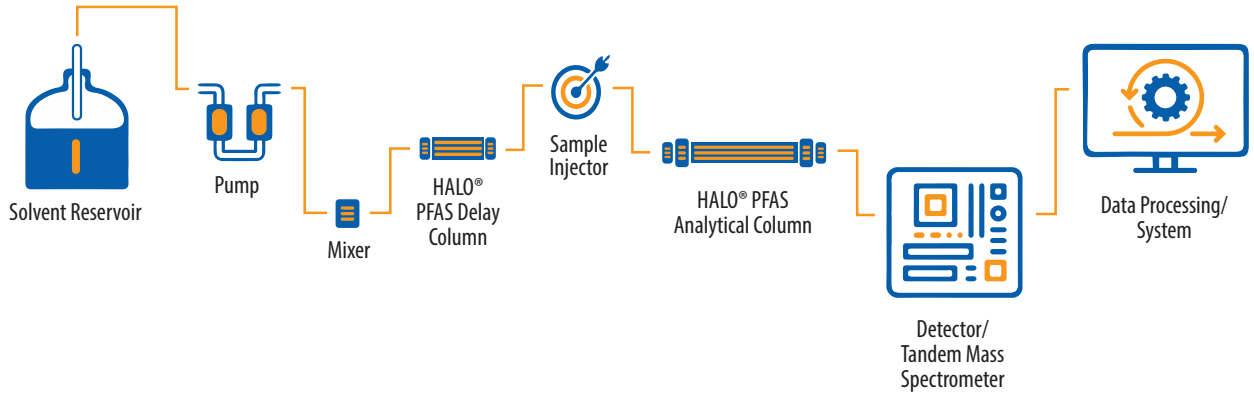
ULTRA SHORT CHAIN

PFAS PCS Phenyl-Hexyl



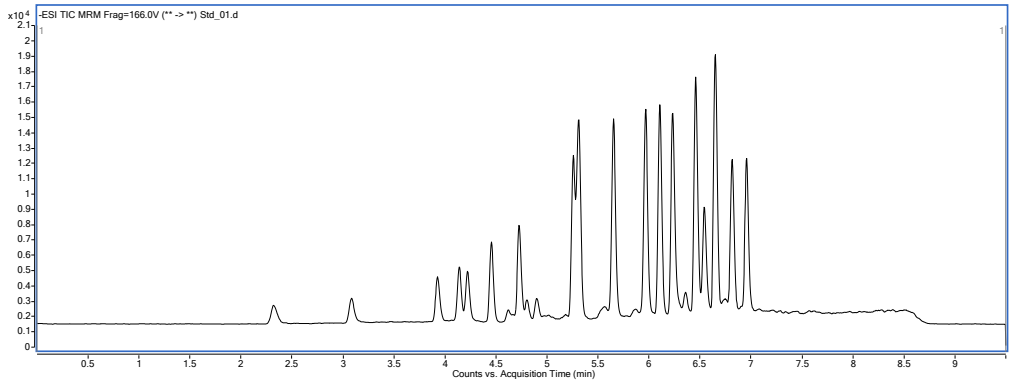
HALO® PFAS DELAY COLUMN

HALO® PFAS Delay is an application assured column solution. The delay column is used to prevent background PFAS contamination from interfering with the PFAS of interest that are separated with the analytical column. The delay column bonded phase is a highly retentive endcapped silane chosen for its ability to demonstrate delay of background instrument PFAS contamination across multiple mobile phase conditions. For this reason, the HALO® PFAS Delay column is placed upstream of the sample injector.



DEMONSTRATION OF THE HALO® PFAS DELAY COLUMN

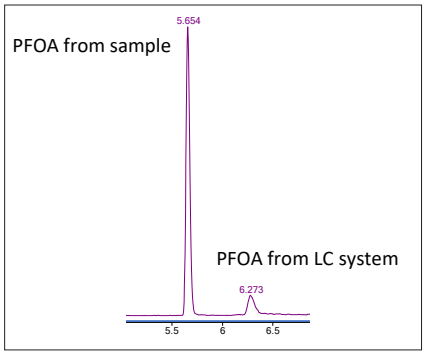
Demonstration of the delay column utility for PFOA extracted ion. The prevalence of PFOA is commonly observed as an instrument materials contaminant- therefore is important to be separated from sample containing PFOA for accurate quantitation.



TEST CONDITIONS

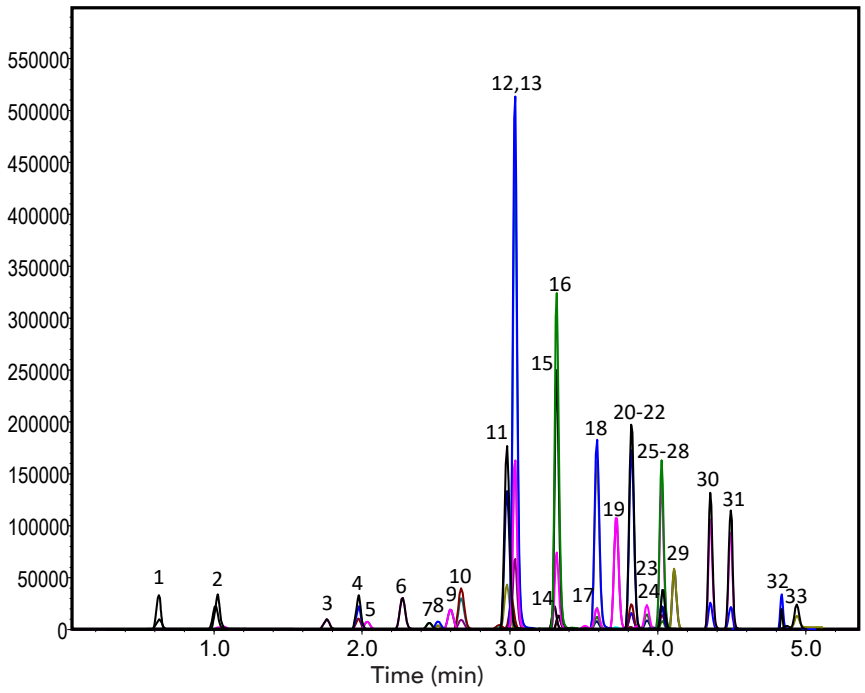
Analytical Column: HALO® PFAS C18, 2.7 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 20 mM Ammonium Acetete
Mobile Phase B: Methanol
Gradient: 20-90 %B in 6 min.; hold @ 90 %B for 2 min.
Flow Rate: 0.4 mL/min.
Pressure: 505 bar
Temperature: 44 °C
Detection: -ESI MRM
Injection Volume: 2.0 µL
Sample Solvent: Methanol (96%) / Water (4%)
LC System: Agilent Triple Quadrupole LC/MS 6400

Data courtesy of STRIDE Center for PFAS Solutions



SPEED: RAPID ANALYSIS OF 33 PFAS COMPOUNDS IN UNDER 5 MINUTES

When speed is important, the HALO® columns can perform a separation of 33 PFAS species found in EPA 537.1, EPA 533, and EPA 8327, completed in under 5 minutes.



PEAK# / COMPOUND

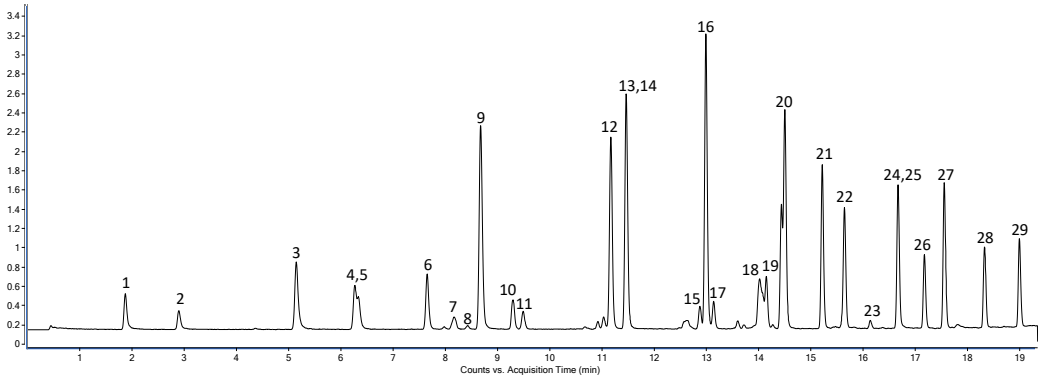
1.	PFBA	18.	PFOS
2.	4:2FTS	19.	9Cl-PF3ONS
3.	PFPeA	20.	8:2FTS
4.	PFBS	21.	PFNS
5.	PFHpS	22.	PFDA
6.	PFPeS	23.	N-MeFOSAA
7.	PFMPA	24.	PFNA
8.	PFHxA	25.	NFDHA
9.	PFEESA	26.	PFUnA
10.	HFPO-DA	27.	N-EtFOSAA
11.	PFHxS	28.	6:2FTS
12.	NaDONA	29.	11Cl-PF3OUdS
13.	ADONA	30.	PFTrDA
14.	FOSA	31.	PFDoA
15.	PFOA	32.	PFTeDA
16.	PFMBA	33.	PFDS
17.	PFHpA		

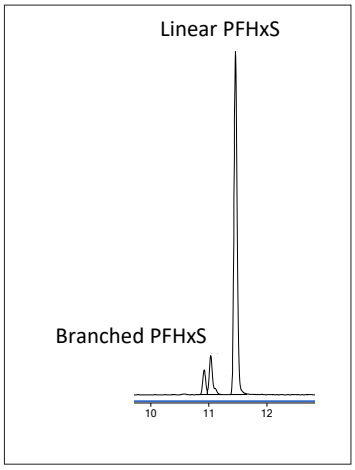
TEST CONDITIONS

Analytical Column: HALO® PFAS C18, 2.7 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 10 mM Ammonium Acetete
Mobile Phase B: Methanol
Gradient: 33-98 %B in 4.0 min.; 98-100 %B in 0.1 min.; hold @ 100 %B for 2min.
Flow Rate: 0.4 mL/min.
Pressure: 479 bar
Temperature: 35 °C
Injection Volume: 2.0 µL
Sample Solvent: Methanol (96%) Water (4%)

METHOD 533: ANALYSIS OF PFAS IN WELL WATER

Method 533 complements EPA Method 537.1 and can be used to test for 11 additional PFAS species. Here we show a clear separation of the branched and linear isomers of PFAS species PFHxS, found in a spiked well water sample.





TEST CONDITIONS

Analytical Column: HALO® PFAS C18, 2.7 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 20 mM Ammonium Acetete
Mobile Phase B: Methanol
Gradient: 20-90 %B in 15 min.; hold @ 90 %B for 5 min.
Flow Rate: 0.4 mL/min.
Pressure: 505 bar
Temperature: 44 °C
Detection: -ESI MRM
Injection Volume: 2.0 µL
Sample Solvent: Methanol (96%) / Water (4%)
LC System: Agilent Triple Quadrupole LC/MS 6400

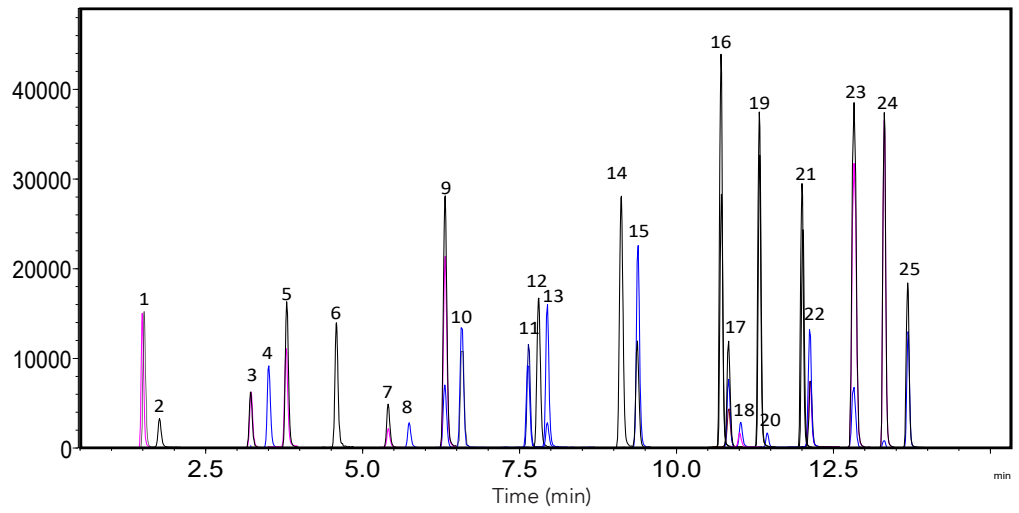
Data courtesy of STRIDE Center for PFAS Solutions

PEAK# / COMPOUND

1.	PFBA	11.	HFPO-DA	21.	8-2FTS
2.	PFMPA	12.	PFHpA	22.	PFDA
3.	PFPeA	13.	PFHxS	23.	NMeFOSAA
4.	PFBS	14.	ADONA	24.	NEtFOSAA
5.	PFMBA	15.	6-2FTS	25.	PFUnA
6.	PFEESA	16.	PFOA	26.	11Cl-PF3OUdS
7.	NFDHA	17.	PFHpS	27.	PFDoA
8.	4-2FTS	18.	PFNA	28.	PFTrA
9.	PFHxA	19.	PFOS	29.	PFTA
10.	PFPeS	20.	9Cl-PF3ONS		

PFAS ANALYSIS ACCORDING TO EPA 533

EPA Method 533 is for drinking water analysis and targets both short and long chain PFAS compounds.



PEAK# / COMPOUND

1. PFBA
2. 4-2FTS
3. PFPeA
4. PFBS
5. PFHpS
6. PFPeS
7. PFmpA
8. PFHxA
9. PFEESA
10. HFPO-DA
11. PFHpA
12. PFHxS
13. ADONA
14. PFOA
15. PFmbA
16. PFNA
17. PFOS
18. 9Cl-PF3ONS
19. PFDA
20. 8-2FTS
21. 6-2FTS
22. NFDHA
23. PFUnA
24. 11Cl-PF3OUdS
25. PFDoA

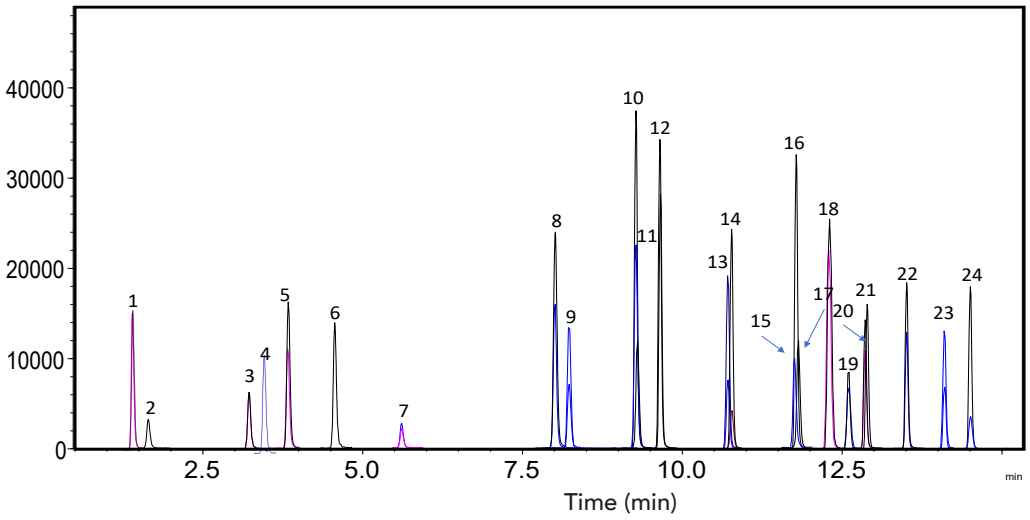
TEST CONDITIONS

Analytical Column: HALO® PFAS C18, 2.7 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 10 mM Ammonium Acetete
Mobile Phase B: Methanol
Gradient: 33-98 %B in 18 min.

Flow Rate: 0.4 mL/min.
Initial Back Pressure: 485 bar
Temperature: 35 °C
Injection Volume: 2.0 µL
Sample Solvent: Methanol (96%) / Water (4%)

PFAS ANALYSIS ACCORDING TO EPA 8327

HALO® PFAS provides a high resolution separation for EPA 8327 used for the analysis of non-potable water samples.



PEAK# / COMPOUND

1. PFBA
2. 4:2FTS
3. PFPeA
4. PFBS
5. PFHpS
6. PFPeS
7. PFHxA
8. PFHpA
9. PFHxS
10. FOSA
11. PFOA
12. PFDS
13. PFNA
14. PFOS
15. PFNS
16. PFDA
17. 8:2FTS
18. N-MeFOSAA
19. 6:2FTS
20. PFUnA
21. N-EtFOSAA
22. PFDoA
23. PFTrDA
24. PFTeDA

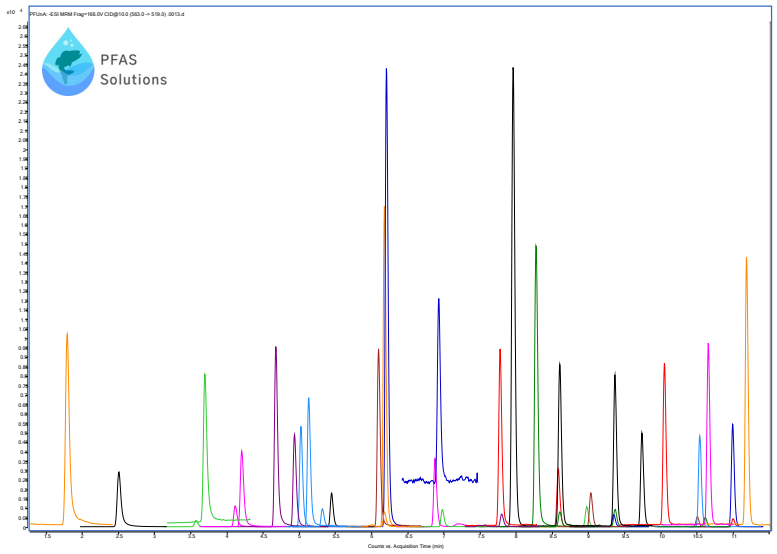
TEST CONDITIONS

Analytical Column: HALO® PFAS C18, 2.7 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 10 mM Ammonium Acetete
Mobile Phase B: Methanol
Gradient: 33-98 %B in 18 min.
Flow Rate: 0.4 mL/min.

Initial Back Pressure: 485 bar
Temperature: 35 °C
Injection Volume: 2.0 µL
Sample Solvent: Methanol (96%) / Water (4%)

METHOD 1633: FORTIFIED SOIL SAMPLE SPIKED WITH PFAS STANDARDS FOLLOWING EPA 1633

The latest EPA 1633 method includes 40 PFAS compounds across nine different compound classes (including linear and branched isomers) using a reversed phase C18 column along with an analytical delay column. The figure below represents a fortified soil sample that has been spiked with each PFAS standard at 5 ppb following solid phase extraction.



METHOD CONDITIONS

Column: HALO 90 Å PFAS C18 2.7µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7µm, 3.0x50 mm
Mobile Phase A: 20 mM Ammonium Acetate
Mobile Phase B: MeOH
Gradient:

Time	%B
0.0	20
12.0	90
15.0	90
15.1	20
18.0	END

Flow Rate: 0.4 mL/min.
Pressure: 505 bar
Temperature: 44 °C
Injection Volume: 2.0 µL
Sample: Field Soil Sample
Sample Solvent: 96:4 Methanol/Water
MS System: Agilent 6400 series
LC System: Agilent 1200 series

EPA 1633 MS CONDITIONS

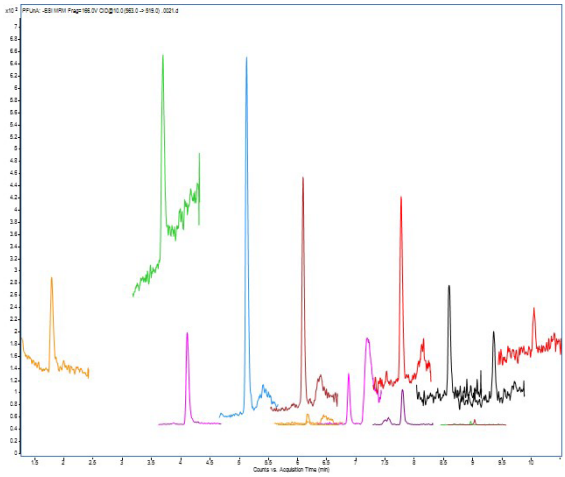
Gas Temp: 130 °C
Nebulizer: 25 psi
Gas Flow: 11 L/min
Sheath Gas Heater: 250 °C
Capillary: 3500 V

Data Courtesy of Center for PFAS Solutions (New Castle, DE)

Analyte	RT (min)
Perfluorobutanoic acid	1.79
Perfluoro-3-methoxypropanoic acid	2.51
3-perfluoropropyl propanoic acid	3.57
Perfluoropentanoic acid	3.70
Perfluorobutanesulfonic acid	4.12
Perfluoro-4-methoxybutanoic acid	4.21
Perfluoro(2-ethoxyethane)sulfonic acid	4.68
Nonafluoro-3,6-dioxaheptanoic acid	4.94
1H, 1H, 2H, 2H-Perfluorohexane sulfonic acid	5.03
Perfluorohexanoic acid	5.14
Perfluoropentanesulfonic acid	5.33
Hexafluoropropylene oxide dimer acid	5.45
Perfluoroheptanoic acid	6.10
Perfluorohexanesulfonic acid	6.18
2H,2H,3H,3H-Perfluorooctanoic acid	6.18
4,8-dioxa-3H-perfluorononanoic acid	6.21
1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid	6.89
Perfluorooctanoic acid	6.93
Perfluoroheptanesulfonic acid	6.99
Perfluorononanoic acid	7.79
Perfluorooctanesulfonic acid	7.81
3-perfluoroheptyl propanoic acid	8.00
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	8.28
1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid	8.59
Perfluorononanesulfonic acid	8.61
Perfluorodecanoic acid	8.61
N-methyl perfluorooctanesulfonamidoacetic acid	8.98
Perfluorooctanesulfonamide	9.04
Perfluorodecanesulfonic acid	9.35
Perfluoroundecanoic acid	9.37
N-ethyl perfluorooctanesulfonamidoacetic acid	9.37
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	9.74
Perfluorododecanoic acid	10.05
N-Methyl Perfluorooctanesulfonamide	10.51
N-Methyl Perfluorooctanesulfonamidoethanol	10.54
Perfluorododecanesulfonic acid	10.62
Perfluorotridecanoic acid	10.66
N-Ethyl Perfluorooctanesulfonamidoethanol	11.00
N-Ethyl Perfluorooctanesulfonamide	11.00
Perfluorotetradecanoic acid	11.19

METHOD 1633: FIELD SOIL SAMPLE

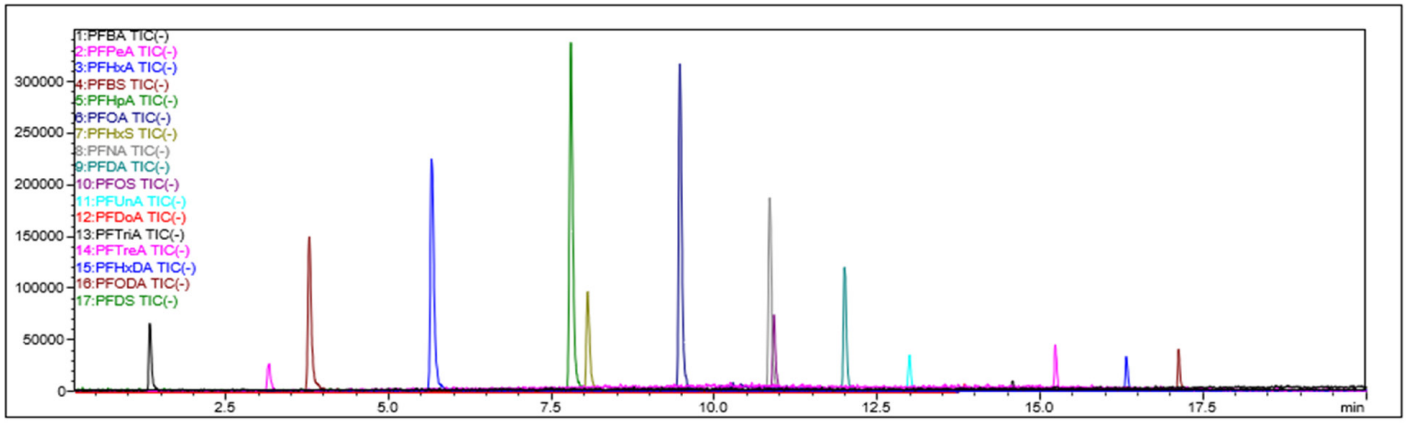
By using the HALO® PFAS C18 column, in conjunction with EPA method 1633, PFAS compounds were detected around 1 ppb with excellent peak shape and resolution.



Analyte	RT (min)
Perfluorobutanoic acid	1.79
Perfluoropentanoic acid	3.70
Perfluorobutanesulfonic acid	4.12
Nonafluoro-3,6-dioxaheptanoic acid	4.94
Perfluorohexanoic acid	5.14
Perfluoroheptanoic acid	6.10
Perfluorohexanesulfonic acid	6.18
2H,2H,3H,3H-Perfluorooctanoic acid	6.18
1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid	6.89
Perfluorononanoic acid	7.79
Perfluorooctanesulfonic acid	7.81
Perfluorodecanoic acid	8.61
N-methyl perfluorooctanesulfonamidoacetic acid	8.98
Perfluorooctanesulfonamide	9.04
Perfluoroundecanoic acid	9.37
N-ethyl perfluorooctanesulfonamidoacetic acid	9.37
Perfluorododecanoic acid	10.05

HALO® PFAS C18 PERFORMANCE IN 2 µm

Mixtures of PFAS are resolved using a combination of methanol and water with ammonium acetate. A C18 90 Å, 2 µm superficially porous particle allows for reduced peak widths and higher peak capacities compared to larger particle sizes.



Peak	Acronym	Collision energy (eV)	RT (min)	m/z
1	PFBA	16	1.32	213.00
2	PFPeA	16	3.15	263.00
3	PFHxA	24	5.65	313.00
4	PFBS	48	3.78	299.00
5	PFHpA	18	7.79	363.00
6	PFOA	17	9.47	413.00
7	PFHxS	46	8.05	399.00
8	PFNA	21	10.83	463.00
9	PFDA	17	11.98	513.00
10	PFOS	45	10.90	499.00
11	PFUnA	18	12.97	563.00
12	PFDS	48	12.97	599.00
13	PFDoA	23	13.84	613.00
14	PFTriA	29	14.57	663.00
15	PFTreA	20	15.23	713.00
16	PFHxDA	19	16.31	813.00
17	PFODA	18	17.11	913.00

TEST CONDITIONS

Column: HALO 90 Å PFAS C18, 2 µm, 2.1x100 mm
Delay Column: HALO® PFAS Delay, 2.7µm, 3.0x50 mm
Mobile Phase A: 10 mM Ammonium Acetate
Mobile Phase B: Methanol
Gradient:

Time	%B
0.0	33.0
18.0	98.0

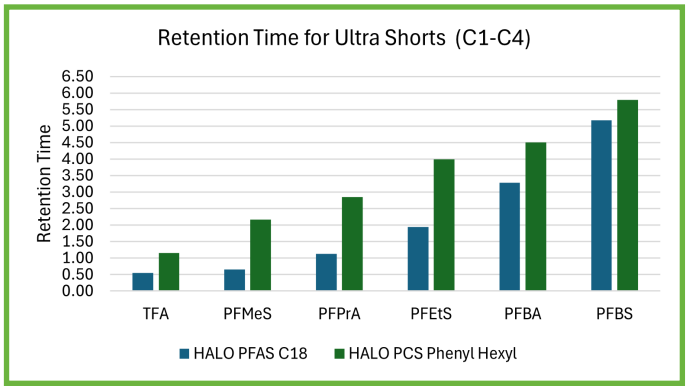
Flow Rate: 0.4 mL/min.
Temperature: 40 °C
Injection Volume: 1.0 µL
Sample Solvent: 70/30 Water/ MeOH
MS System: Shimadzu 8060-NX

LC System: Shimadzu Nexera X2
Detector: MS (ESI-), MRM
Nebulizing Gas: Flow: 2 L/min.
Heating Gas Flow: 10 L/min.
Interface Temperature: 300 °C
DL Temperature: 250 °C
Heat Block Temperature: 400 °C
Drying Gas Flow: 15 L/min.

EMERGING PFAS TESTING - THE RETENTION CHALLENGE FOR ULTRA SHORT CHAIN PFAS COMPOUNDS

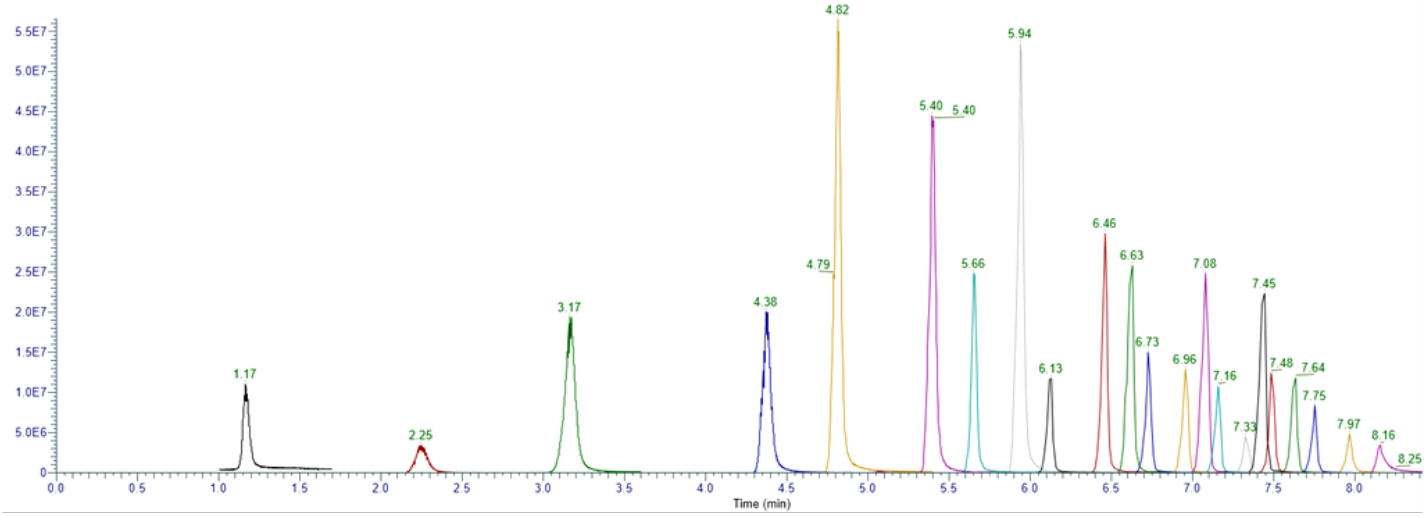
Advanced Materials Technology has developed a positively charged surface (PCS) SPP silica column that enhances retention of ultra-short PFAS under reversed-phase conditions.

This PCS particle technology has shown advantages for short chain PFAS HPLC analyses due to its *increased retention.*



ULTRA SHORT AND LONG CHAIN PFAS USING A HALO® PFAS PCS PHENYL-HEXYL COLUMN

A broad gradient (2–95% organic) was employed to ensure effective separation of both polar and non-polar PFAS compounds. The use of a HALO® PFAS PCS Phenyl-Hexyl column, in combination with a HALO® PFAS Delay Column, enabled robust retention and resolution of ultra short to long chain PFAS analytes. The PCS (Positively Charged Surface) ligand provides enhanced interaction with highly polar, short chain PFAS—resulting in significantly improved retention compared to conventional C18 phases. This unique selectivity facilitates comprehensive PFAS profiling, including compounds that typically elute early or are poorly retained on traditional reversed-phase columns.

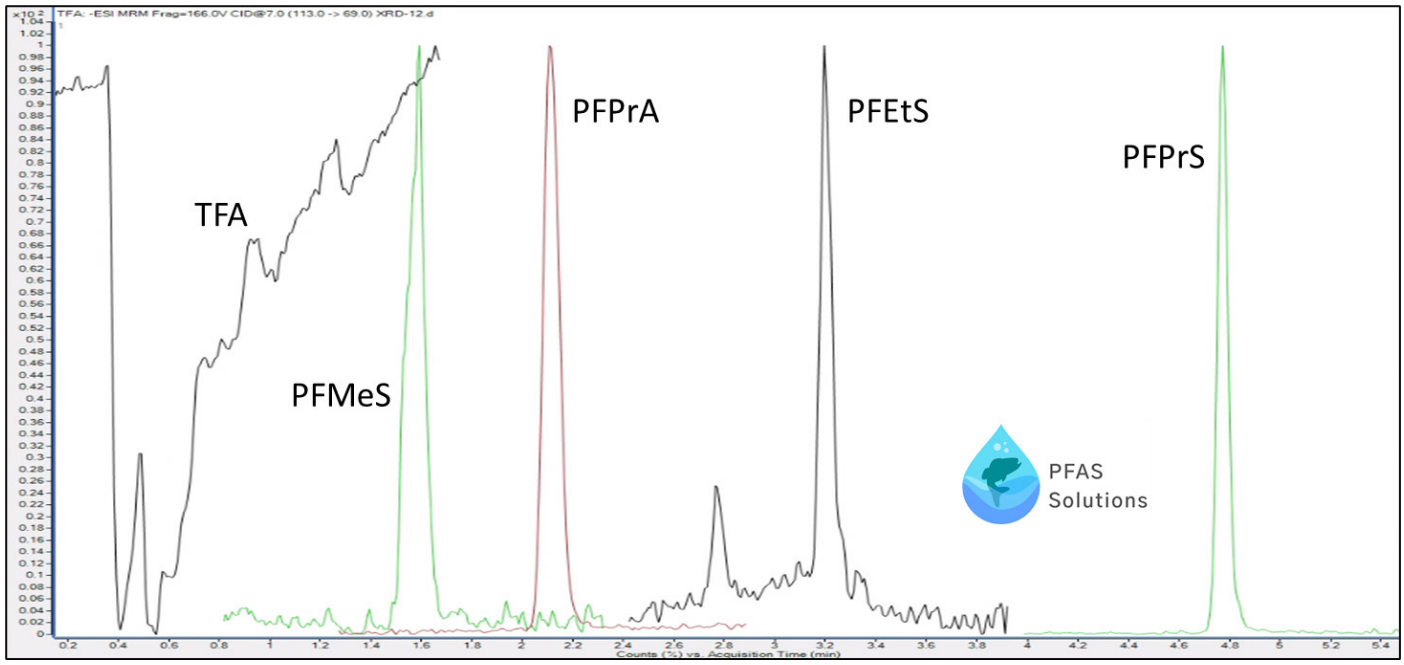


PEAK IDENTITIES

1. TFA (1.17, m/z: 113.2, CE: 15)
2. PFMtS (2.25, m/z: 148.95, CE: 47)
3. PFPrA (3.17, m/z: 163.3, CE: 14)
4. PFEtS (4.38, m/z: 199.25, CE: 48)
5. PFBA (4.82, m/z: 213.00, CE: 16)
6. PFPrS (5.40, m/z: 249.20, CE: 48)
7. PFPeA (5.66, m/z: 263.00, CE: 16)
8. PFBS (5.94, m/z: 299.00, CE: 48)
9. PFHxA (6.13, m/z: 313.00, CE: 24)
10. PFHpA (6.46, m/z: 363.00, CE: 18)
11. PFHxS (6.63, m/z: 399.00, CE: 46)
12. PFOA (6.73, m/z: 413.00, CE: 17)
13. PFNA (6.96, m/z: 463.00, CE: 21)
14. PFOS (7.08, m/z: 499.00, CE: 45)
15. PFDA (7.16, m/z: 513.00, CE: 17)
16. PFUnA (7.33, m/z: 563.00, CE: 18)
17. PFDS (7.45, m/z: 599.00, CE: 48)
18. PFDoA (7.48, m/z: 613.00, CE: 23)
19. PFTriA (7.64, m/z: 663.00, CE: 29
20. PFTreA (7.75, m/z: 713.00, CE: 20)
21. PFHxDA (7.97, m/z: 813.00, CE: 19)
22. PFODA (8.16, m/z: 913.00, CE: 18)

ULTRA SHORT CHAIN PFAS ANALYSIS IN WELL WATER

PFAS HPLC methods are continuing to improve including newer methods involving no solid phase extraction steps, reducing time and money in laboratory workflows. This is achieved by injecting a large amount of sample on column. Below is an example of an ultra short chain PFAS analysis in a well water sample, **avoiding solid phase extraction** and injecting a large injection volume (20µL) for analysis.



TEST CONDITIONS

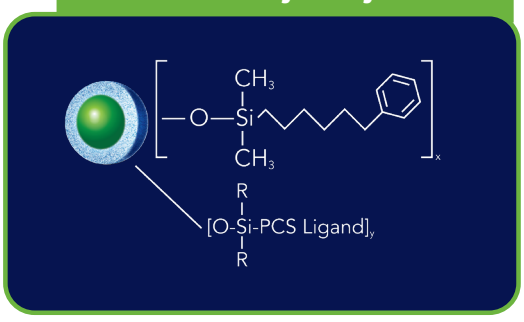
Column: HALO 90 Å PFAS PCS Phenyl-Hexyl, 2.7 µm, 2.1x100 mm
Delay Column: HALO 160 Å PFAS Delay, 2.7 µm, 3.0x50 mm
Mobile Phase A: 5mM Ammonium Formate, 0.05% Formic Acid
Mobile Phase B: MeOH
Gradient:

Time	%B
0.0	2
7.0	95
9.0	95
11.0	2
15.0	2

Flow Rate: 0.4 mL/min.
Back Pressure: 452 bar
Temperature: 40 ºC
Injection: 2.0 µL (chromatogram left); 20µL (chromatogram above)
Sample Solvent: Water/ MeOH

Samples:
LGC ultra short chain: (C1-C4) DRE-A30000064MW
Wellington Labs: (C4-C18) PFAC-MXB
Sheath Gas: 25
Aux Gas Flow: 10
Sweep Gas Flow: 1
Capillary Temp: 325 °C

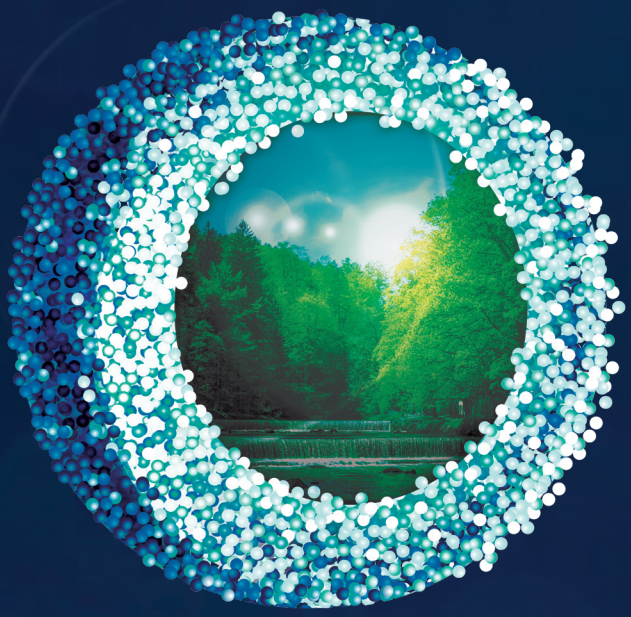
PFAS PCS Phenyl-Hexyl



PRODUCT CHARACTERISTICS AND PART NUMBERS

ATTRIBUTE	PFAS C18	PFAS PCS Phenyl-Hexyl
Ligand	dimethyloctadecylsilane	6-phenylhexyldimethylsilane
Particle Size (µm)	2 / 2.7	2.7
Pore Size (Å)	90	90
Carbon Load (%)	7.2 / 7.7	6.1
Surface Area(m^2/g)	125	125
Endcapped (Y/N)	Yes	Yes
Low pH Limit/Max T	2/60 °C	2/60 °C
High pH Limit/Max T	9/40 °C	7/40 °C
100% Aqueous Compatible	No	Yes

COLUMN TYPE	PARTICLE SIZE	DIMENSION ID X LENGTH (in mm)	PART NUMBER
PFAS C18	2 µm	2.1 x 50	91812-413
		2.1 x 100	91812-613
		3.0 x 50	91813-413
		3.0 x 100	91813-613
	2.7 µm	2.1 x 50	92812-413
		2.1 x 100	92812-613
		2.1 x 150	92812-713
		2.1 x 250	92812-913
		3.0 x 50	92813-413
		3.0 x 100	92813-613
		3.0 x 150	92813-713
		3.0 x 250	92813-913
PFAS PCS Phenyl-Hexyl	2.7 µm	2.1 x 50	92882-419
		2.1 x 100	92882-619
		2.1 x 150	92882-719
		3.0 x 50	92883-419
		3.0 x 100	92883-619
		3.0 x 150	92883-719
DELAY	2.7 µm	2.1 x 50	92112-415
		3.0 x 50	92113-415
		4.6 x 50	92114-415
Guard: C18	2.7 µm	2.1 x 5	92812-102
	2 µm	2.1 x 5	91812-102
Guard: PCS PhHx	2.7 µm	2.1 x 5	92812-118
Guard Column Holder			94900-001



HALO®

ORDERING INFORMATION:

Within the U.S.A.
email: sales@advanced-materials-tech.com
website: halocolumns.com/shop/

Outside the U.S.A.
website: halocolumns.com/find-a-distributor/

If you cannot find what you are looking for, please reach us at:
email: support@advanced-materials-tech.com
website: halocolumns.com/contact-us/

HALO®

advancedmaterialstechnology

halocolumns.com

AMT25_PFAS_Rev_0