Technical Overview

Reduce PFAS Background with the Agilent PFC-Free* HPLC Conversion Kit

An ideal solution for trace level PFAS analysis with LC/MS/MS

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Introduction

Per- and polyfluoroalkyl substances (PFAS) are a group of persistent organic pollutants, widely found in the environment.[1] To protect people from exposure to these pollutants international, national, and regional agencies such as the United States Environmental Protection Agency (US EPA) and the International Organization for Standardization (ISO) provide methods for trace-level analysis of these compounds. For example, US EPA methods 533 and 537.1, as well as ISO method 21675 can be used for the analysis of drinking water with liquid chromatography/tandem mass spectrometry (LC/MS/MS).

High-performance liquid chromatography (HPLC) instruments in their standard configuration contain per- and polyfluorinated compounds (PFCs), including fluoropolymers such as PTFE, PFA, etc. These materials are used because of their chemical inertness, ensuring the compatibility of the LC instruments with a broad range of acids, bases, and organic solvents. However, during the production of PFC, per- and polyfluorinated alkyl substances (PFASs), such as perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), or replacement chemicals with similar properties are used as processing agents. Traces of these PFAS processing agents can remain in fluoropolymers. When running PFAS analysis at the ppb level and below, using LC/MS/MS instruments, the PFAS leaching from the LC instrument during operation can cause an increased background. This increased background can have a severe impact on meeting the required quantification and detection limits set by regional and national regulations. Therefore, it is up to the user to take the necessary steps to minimize the impact of the LC/MS system on the analytical results. Two recommendations from the US EPA are (1) to replace standard solvent lines with alternative ones made of PEEK and (2) to use a delay column, which can help to further reduce the background, especially if it is caused by the mobile phase.

Other Sources of PFAS background

- Solvents
- Vial and caps (PTFE-containing septa)
- Fluoropolymer tubing in sample preparation devices
- Labware

Overview

Agilent offers the PFC-free HPLC conversion kit, a ready-to-use, easy-to-install kit for minimizing PFAS background from LC instruments, to support customers running PFAS applications. The PFC-free LC conversion kit offers substitutes for all critical parts of the LC system made from materials that contain organic fluorine compounds. The kit also includes the newly developed Agilent InfinityLab PFC delay column to delay potential PFC impurities from the mobile phases. The delay column is installed in the (U)HPLC pump in front of the autosampler and should not be used as a separation column. The new solvent lines in this kit are made of polypropylene (PP), which offers the same reduction of PFAS background, compared to PEEK, while improving the usability, due to the higher flexibility and transparency. The new and uniquely developed polypropylene Stay Safe bottle caps lack any fluorinated materials and help to minimize organic solvent vapors contaminating the lab environment. The new polypropylene Stay Safe caps are LC/MS compatible with mobile phases typically used for PFAS workflows. The kit includes Agilent InfinityLab Quick Connect fittings to allow quick, easy, and tool-free delay column connection. The additional parts make this kit a full solution, including tags for easy identification of the special parts in the converted LC instrument. Table 1 shows a comparison of the standard LC parts and the replacement parts of the kit, including details about the materials used.

Table 1. Parts and materials used in standard and converted LC systems.

Parts Group	LC in Standard Configuration	PFC-free HPLC Conversion Kit
Bottle Head Assemblies	Bottle head assembly long, including: FEP solvent lines; FEP bottle cap insert; PTFE frit adapter for glass solvent inlet filter; ETFE ferrule 1/8" with stainless steel lock ring; Optional: InfinityLab Stay Safe cap with PTFE bottle cap insert and PFA tubing fitting	PFC-free bottle head assembly (5004-0004), including: PP solvent line; stainless steel solvent inlet filter (01018-60025), PEEK ferrule 1/8" with stainless steel lock ring (0100-1919), PFC-free InfinityLab Stay Safe cap with PP cap insert and PP tubing fitting
Pump Head Outlet Connector	High-pressure filter assembly with PTFE filter frits	Pump head adapter assembly (G1312-60001, does not contain filter)
Inline-Filter	None	InfinityLab Quick Change inline filter (5067-1602) with PEEK/stainless steel filter discs (5067-1613)
Multisampler Tubing	Multiwash tubing kit, including: FEP tubing; ETFE ferrules	PFC-free multiwash tubing kit (5004-0003) including: PEEK tubing (0890-1761) cut to length, PEEK ferrules 1/16" with stainless steel lock ring (0100-1690)

Abbreviations: ETFE: Ethylene tetrafluoroethylene; FEP: Fluorinated ethylene propylene; PEEK: Polyether ether ketone; PFA: Perfluoroalkoxy alkanes; PP: Polypropylene; PTFE: Polytetrafluoroethylene.

For detailed installation instructions, please see technical overview "PFC-Free HPLC Conversion Kit - Installation and Use Instruction" (01200-90001).

The kit is designed to be installed on an Agilent 1290 Infinity II LC with a high-speed pump (G7120A) and an Agilent 1290 Infinity II Multisampler (G7167B) with multiwash option. These LC modules provide the best possible performance for PFAS analysis applications, including wash options for cleaning the injection needle of the sampler, the needle seat, and the needle seat capillary with several different wash solvents to reduce carry over from analytes potentially sticking to the surface of these parts. However, some parts of the kit are universal parts and can be used with any other LC pump or sampler module, such as the bottle head assemblies for the mobile phases. For more details, please see the "Converting other Agilent LC Modules" section.

Agilent recommends the use of the full kit on LC instruments dedicated for PFAS analysis. The kit was tested with mobile phases common in PFAS analysis applications, including water, methanol, acetonitrile, and mixtures of these as well as with mild additives at relatively low concentrations, such as 20 mM ammonium acetate or 0.1% acetic acid. For users running applications other than PFAS analysis on the same LC instrument, it is up to the user to verify the compatibility of the kit parts with the mobile phases used. If there are issues with compatibility, the use of the delay column only is recommended.

Reducing PFAS background from the system

The following steps should be taken to reduce PFAS background from the LC system:

1. Replace PFC materials from the LC by installing the PFC-free LC conversion kit.
2. The degasser and solvent selection valve should be bypassed as part of the installation. Agilent suggests vacuum degassing or helium sparkling to degas the mobile phases, if necessary.
3. Use the InfinityLab PFC delay column for maximum PFAS background reduction.

The success of these steps can be demonstrated by comparing different LC system setups, with one in standard configuration and one converted according to the steps listed.

PFAS background reduction with the PFC-free LC conversion kit

The success of these instructions for reducing PFAS background was proven by comparing the following system setups:

- LC system in standard configuration, without delay column (std LC setup)
- LC system with PFC-free LC conversion kit installed, without delay column (PFC-free LC setup)
- LC system in standard configuration, with delay column installed (std LC setup with delay column)
- LC system with PFC-free LC conversion kit installed, including delay column (PFC-free LC setup with delay column)

Experimental

LC configuration and parameters

Parameter	Value
Instruments	Agilent 1290 Infinity II High Speed Pump (G7120A)
	Agilent 1290 Infinity II Multisampler with multiwash option (G7167B)
	Agilent 1290 Infinity II Multicolumn Thermostat (G7116B)
Needle Wash	Methanol/water (50/50 v/v), 10 seconds
Seat Backflush	Methanol/water (10/90 v/v), 10 seconds
Sample Diluent	Methanol/water (80/20 v/v)
Multisampler Temperature	10 °C
Injection Volume	1 µL
Analytical Column	Agilent ZORBAX Eclipse Plus C18 RRHD 2.1 × 50 mm, 1.8 µm (959757-902) with guard column Agilent ZORBAX Eclipse Plus C18 RRHD 2.1 × 5 mm, 1.8 µm (821725-901)
Column Temperature	50 °C
Delay Column (if used)	Agilent InfinityLab PFC delay column 4.6 × 30 mm (5062-8100)
Mobile Phase A	5 mM ammonium acetate in water
Mobile Phase B	5 mM ammonium acetate in methanol
Flow Rate	0.4 mL/min
Gradient	Time (min) %A %B 0 90 10 0.5 90 10 2.5 45 55 9 10 90 9.5 0 100 11.5 0 100 11.6 90 10 14 90 10
Stop Time	14 minutes
Post Time	0.3 minutes

MS configuration and parameters

Parameter	Value
Instrument	Agilent G6495C LC triple quadrupole MS
Ion Polarity	Negative
MS mode	dynamic MRM with 1 min time windows
Drying Gas Temperature	250 °C
Drying Gas Flow	11 L/min
Nebulizer Pressure	25 psi
Sheath Gas Temperature	375 °C
Sheath Gas Flow	11 L/min
Capillary Voltage	–2500 V
Nozzle Voltage	0 V
iFunnel	High: 90 V; Low: 60 V
Cell Accelerator Voltage	5 V

Results

The LC system in standard configuration caused very high background levels of some PFASs, making it impossible to run trace level PFAS analysis. Adding just a delay column to this system setup, delays main portion of the background, so it elutes after the dMRM time window, improving the system performance significantly. However, the delay column can only delay background originating from sources upstream of its installation position, including the solvent lines, and the mobile phases, for example. Any parts downstream of the delay column containing PFAS, will still cause background. This includes the wash solvent lines, the wash solvents, the sample solvents, and the vials and caps for example. When using the PFC-free LC conversion kit without the delay column, much less PFAS background was observed compared to the standard LC setup. This shows the benefit of using alternative materials, not made of fluorinated polymers, throughout the flow path. Nevertheless, the replacement of the critical materials does not solve the issue of background completely. Most solvents contain PFAS at least in trace levels, for example, so only using the full PFC-free LC conversion kit, including the delay column will eliminate the PFAS background completely.

Table 1. MRM transitions (qualifier transition settings in brackets).

Compound	Precursor (*m/z*)	Product (*m/z*)	Collision Energy (V)
PFBA (Perfluorobutanoic acid)	213	169 (NA)	6 (NA)
PFPeA (Perfluoropentanoic acid)	263	219 (NA)	6 (NA)
PFHxA (Perfluorohexanoic acid)	313	269 (119)	6 (22)
PFHpA (Perfluoroheptanoic acid)	363	319 (169)	6 (18)
PFOA (Perfluorooctanoic acid)	413	369 (169)	6 (18)
PFNA (Perfluorononanoic acid)	463	419 (219)	10 (18)
PFDA (Perfluorodecanoic acid)	513	469 (269)	6 (18)
PFUnDA (Perfluoroundecanoic acid)	563	519 (269)	12 (16)
PFDoDA (Perfluorododecanoic acid)	613	569 (319)	14 (22)
PFTrDA (Perfluorotridecanoic acid)	663	619 (169)	14 (34)
PFTeDA (Perfluorotetradecanoic acid)	712.9	669 (169)	10 (38)
PFHxDA (Perfluorohexadecanoic acid)	812.9	769 (369)	10 (26)
PFODA (Perfluorooctadecanoic acid)	912.9	868.9 (369)	10 (30)
PFBS (Perfluorobutane sulfonic acid)	298.9	99 (80)	44 (36)
PFPeS (Perfluoropentane sulfonic acid)	348.9	80 (99)	40 (36)
PFHxS (Perfluorohexane sulfonic acid)	398.9	80 (99)	48 (44)
PFHpS (Perfluoroheptane sulfonic acid)	448.9	80 (99)	50 (46)
PFOS (perfluorooctanesulfonic acid)	498.9	80 (99)	56 (56)
PFNS (Perfluorononane sulfonic acid)	548.9	80 (99)	76 (48)
PFDS (Perfluorodecane sulfonic acid)	598.9	80 (99)	60 (60)
4:2 FTS (4:2 Fluorotelomer sulfonic acid)	326.9	307 (81)	16 (28)
6:2 FTS (6:2 Fluorotelomer sulfonic acid)	426.9	407 (81)	28 (32)
8:2 FTS (8:2 Fluorotelomer sulfonic acid)	526.9	507 (80)	32 (52)
8:2 FTUCA (8:2 Fluorotelomer unsaturated carboxylic acid)	457	393 (343)	28 (42)
8:2 diPAP (8:2 Perfluoroalkyl phosphate diester)	989	543 (97)	20 (36)
ADONA (Dodecafluoro-3H-4,8-dioxanoate)	377	251 (85)	12 (36)
FOSA (Perfluorooctane sulfonamide)	497.9	78 (169)	38 (20)
MeFOSAA (N-Methyl perfluorooctanesulfonamidoacetic acid)	570	419 (512)	20 (20)
EtFOSAA (N-Ethyl perfluorooctanesulfonamidoacetic acid)	584	419 (526)	20 (20)
MeFOSA (N-Methyl perfluorooctane sulfonamide)	512	169 (219)	32 (28)
EtFOSA (N-Ethyl perfluorooctane sulfonamide)	526	169 (219)	28 (28)
PFMPA (Perfluoro-3-methoxypropanoic acid)	229	85 (NA)	10 (NA)
PFMBA (Perfluoro-4-methoxybutanoic acid)	279	85 (NA)	10 (NA)
PFEESA (Perfluoro (2-ethoxyethane) sulfonic acid)	314.9	134.9 (69)	20 (60)
NFDHA (Nonafluoro-3,6-dioxaheptanoic acid)	295	201 (85)	8 (28)
HFPO-DA (Hexafluoropropylene oxide dimer acid)	285 $[M\text{-}HCO_2]^-$	185 (169)	16 (4)
9Cl-PF3ONS (9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid)	530.9	350.9 (83)	28 (32)
11Cl-PF3OUdS (11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)	630.9	450.9 (83)	32 (32)

The kit was tested with the full list of 38 analytes described in the experimental section. The 38 analytes cover several standard and regulatory methods including US EPA methods 533, 537.1, 8327 and ISO method 21675.[2,3,4,5] No background was detected during the tests for 36 out of the 38 analytes. Traces of PFBA (perfluorobutanoic acid) and 6:2 FTS (6:2 fluorotelomersulfonic acid) were found at levels that would equal 0.02 ng/L or below, when injecting 10 µL of extract from a water sample, concentrated 250-fold during SPE sample preparation. As examples, Figures 1 and 2 show chromatograms of PFHpA (perfluoroheptanoic acid) and PFNA (perfluorononanoic acid) from blank injections using the different LC system setups, along with an injection of 100 fg of the analytes on column for reference. Note that the use of a delay column after the mixing point causes a delay of the gradient and therefore a shift in retention times of the analyte peaks, when running the same gradient.

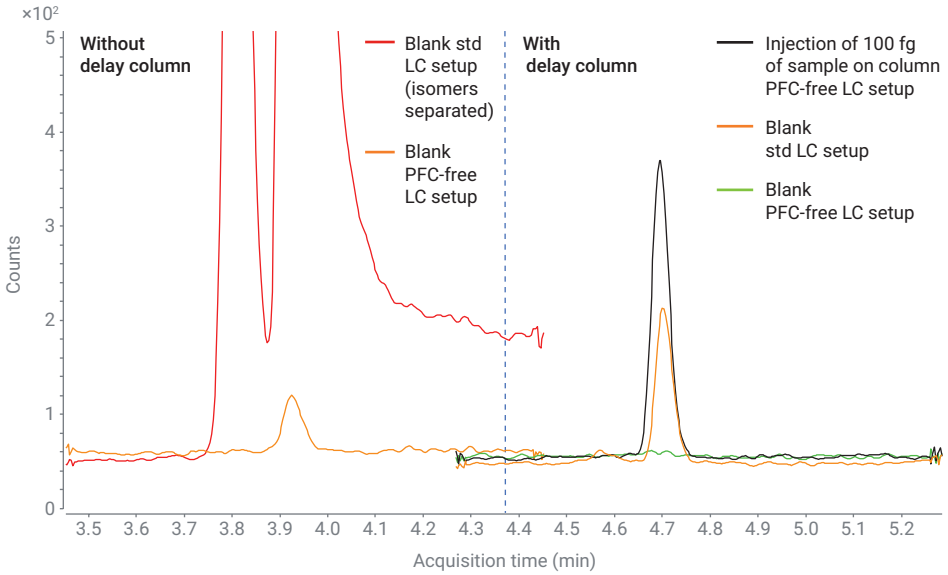

Figure 1. PFHpA blank and sample chromatograms from different LC system setups.

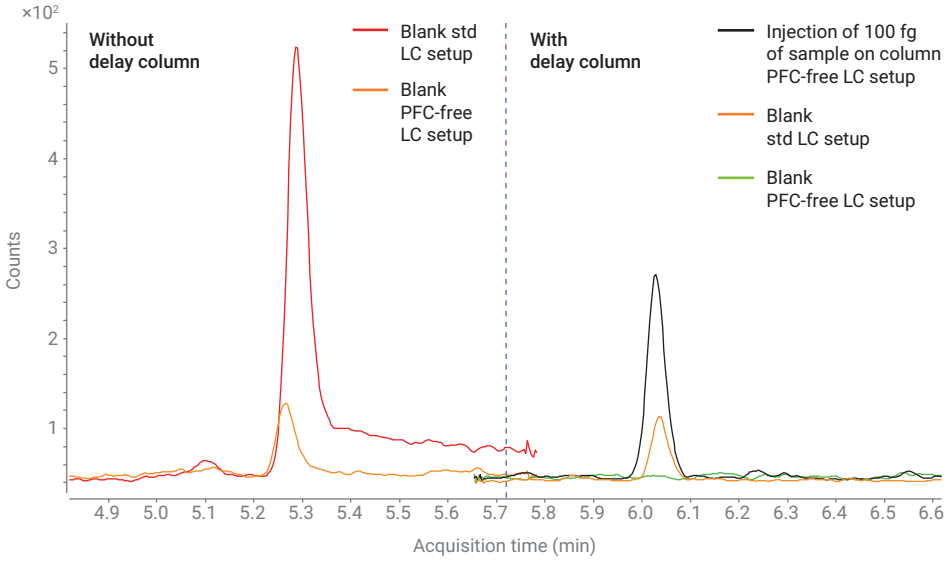

Figure 2. PFNA blank and sample chromatograms from different LC system setups.

The background levels can be calculated from calibration curves. Figures 3 and 4 show the calibration curves for PFHpA and PFNA from different LC system setups.

Table 2 shows a comparison of PFHpA and PFNA background levels calculated from the calibration curves (intercept divided by slope) recorded by running the LC in different configurations.

Delay column

The US EPA and other authorities recommend the installation of a delay (or isolator) column before the injection valve, when running PFAS analysis. The purpose of this column is to delay trace level background PFAS analytes from the pump or the mobile phase, so that they do not interfere with the peak from the sample or standard injected.

The InfinityLab PFC delay column is designed to provide ideal performance for PFAS analysis. It can be used up to 1200 bar instrument operating pressure, so it can be used in ultrahigh performance liquid chromatography (UHPLC) methods with long sub-2 µm columns. The delay column itself, however, does not add much to the system backpressure during operation, due to the column dimensions and the stationary phase used. Furthermore, the stationary phase offers excellent retention for PFAS background to achieve a baseline separation between the background peaks and the peaks from the samples or standards injected. At the same time, it does not retain the background analytes too much, so after a short time of running a high organic ratio of the mobile phase though it at the end of a gradient run, the delay column is flushed and ready for the next analysis run.

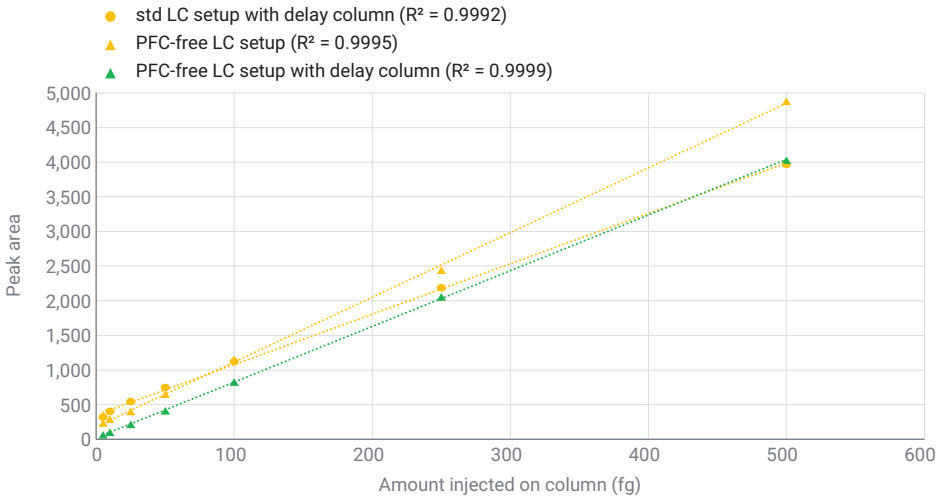

Figure 3. Calibration curves for PFHpA from different LC system setups (the standard LC setup is not shown in this case).

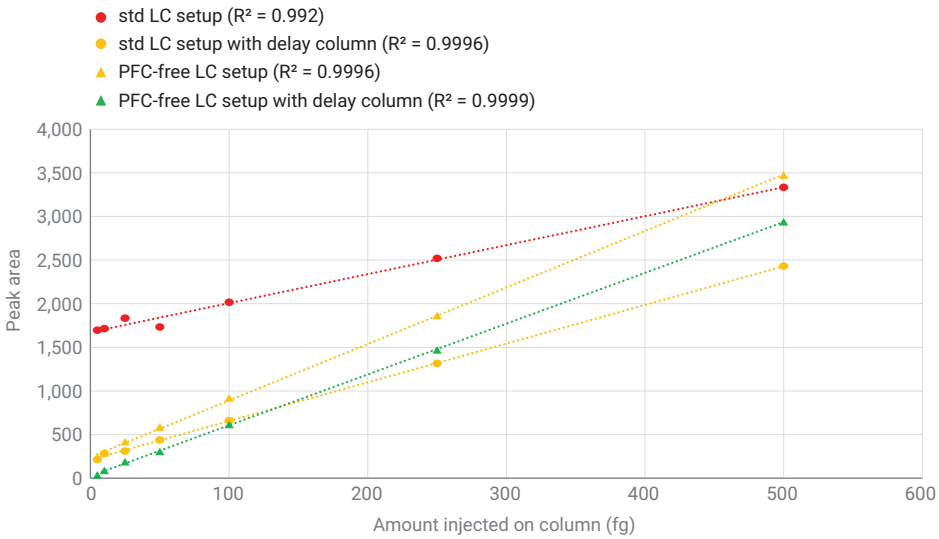

Figure 4. Calibration curves for PFNA from different LC system setups.

Table 2. PFHpA and PFNA background levels calculated from calibration curves.

LC Configuration	PFHpA Background (fg)	PFNA Background (fg)
Standard LC Setup	>3,000	>500
Standard LC Setup With Delay Column	48	48
PFC-free LC Setup	20	37
PFC-free LC Setup With Delay Column	<2 (below detection limit)	<7 (below detection limit)

Proven delay capability

To prove the suitability of the delay column, the method mentioned previously was run with PFAS analytes spiked to the aqueous mobile phase at a concentration of 10 ng/L. The chromatogram in Figure 5 shows a very good baseline separation of the analyte peak of 1 pg injected on column, even in the case of the most critical analyte in respect of the retention time difference (perfluoropentanoic acid, PFPeA) used during this test. Table 3 contains a list with a set of common PFAS analytes covering a good range of molecule chain lengths, proving the suitability of the delay column for PFAS analysis. ΔRT refers to the retention time difference between the background peak and the sample peak (ΔRT = retention time peak apex background peak – retention time peak apex sample peak).

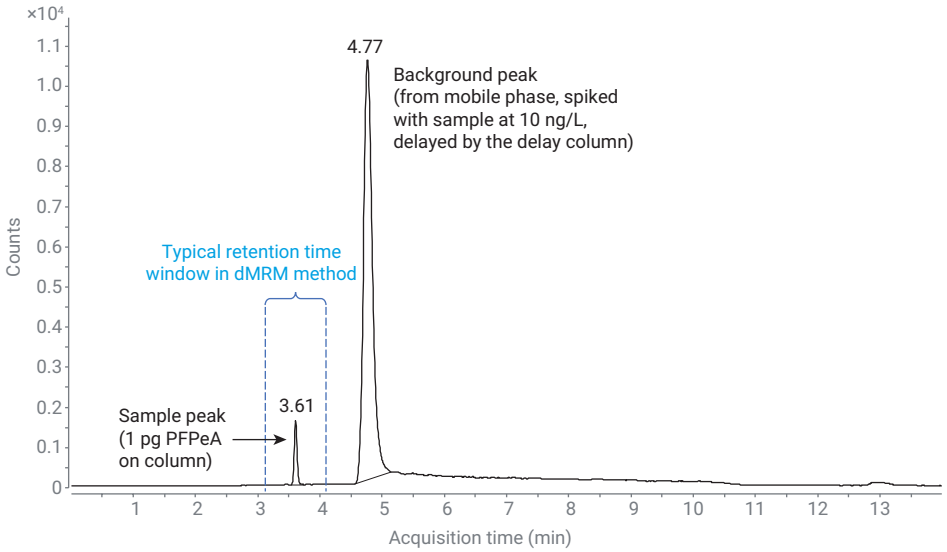

Figure 5. Chromatogram showing the peak from a 1 pg PFPeA injection with very good baseline separation from the background peak of a spiked mobile phase.

Table 3. Common PFAS background delay when using the PFC delay column.

Analyte	ΔRT (min)
PFBA (Perfluorobutanoic acid)	1.5
PFPeA (Perfluoropentanoic acid)	1.2
PFHxA (Perfluorohexanoic acid)	1.6
PFHpA (Perfluoroheptanoic acid)	2.0
PFOA (Perfluorooctanoic acid)	2.1
PFNA (Perfluorononanoic acid)	2.1
PFDA (Perfluorodecanoic acid)	2.1
PFUnA (Perfluoroundecanoic acid)	2.0
PFDoA (Perfluorododecanoic acid)	1.9
PFTrA (Perfluorotridecanoic acid)	2.2
PFTeA (Perfluorotetradecanoic acid)	1.7
PFBS (Perfluorobutanesulfonic acid)	1.2
PFHxS (Perfluorohexanesulfonic acid)	2.0
PFOS (Perfluorooctanesulfonic acid)	2.1

The InfinityLab PFC delay column is designed to be used as a delay column and should not be used as a separation column.

The InfinityLab PFC delay column is a high-quality product, offering a long lifetime. Upon extended use, it will still need to be replaced. It is recommended to replace the delay column, when the background peak comes closer to the injection peak and appears in the retention time window of the respective analyte, so it could impact the result of the analysis. The column should be replaced after six months at the latest.

Conclusion

With the PFC-free HPLC conversion kit, a complete, ready-to-use solution for trace-and ultratrace-level PFAS analysis was created. It consists of PFC-free parts to replace PFC materials present in the original HPLC system setup and includes a newly developed InfinityLab PFC delay column, for maximum possible PFAS system background reduction.

Converting other Agilent LC modules

The PFC-free conversion kit contains several universal conversion parts, which can be used with other HPLC instruments. The use of the PFC-free bottle head assemblies in combination of the delay column will help to reduce the PFAS system background contaminations of any system significantly. However, due to technical construction reasons, not all potential PFAS background would be removed this way, and other disadvantages over the use of the recommended LC modules would be present. The PFAS background reduction capability of the conversion kit was tested with the recommended modules only. Some pumps use black PTFE wash seals by default, including the recommended Agilent 1290 Infinity II High Speed Pump (G7120A; SN DEBAY00455 and higher or SN DEBA200500 and higher; lower SNs had yellow PE (polyethylene) wash seals by default). During testing within the development of the conversion kit, the PTFE wash seals did not cause any issues with PFAS background. In case of concerns, these can be replaced with yellow PE wash seals (0905-1718), as an option. Table 4 lists options for the conversion of Agilent LC modules other than the recommended 1290 Infinity II Multisampler with multiwash option (G7167B) and the 1290 Infinity II High Sped Pump (G7120A).

The use of quaternary low-pressure mixing pumps should not be considered for PFAS analyses.

Table 4. Recommendations and trade-offs when using alternative LC modules.

Module	Recommendations	Trade-offs
Agilent 1290 Infinity High Speed Pump (G4220A)	Convert the module as described for the 1290 Infinity II High Speed Pump in "PFC-Free HPLC conversion kit - Installation and Use Instruction" *Optional (SN DEBB06078 and higher or SN DEBAA06133 and higher):* Exchange black PTFE wash seals with yellow PE wash seals (0905-1718).	None
Agilent 1260 Infinity II/Infinity Binary Pumps (G7112B/G1312B) and older Binary Pumps	Use a PEEK adapter 1/4-28 to 10–32 (0100-2298) to connect solvent lines to active inlet valves. Remove the PTFE filter from the manual purge valve. Install a InfinityLab Quick Change inline filter (5067-1602) to the purge valve outlet. Install a delay column between the inline filter and the injection valve. If present, exchange the black PTFE pump seals with yellow PE pump seals (0905-1420). *Optional:* If present, exchange the black PTFE wash seals with yellow PE wash seals (0905-1718).	Increased gradient delay volume, causing increased retention times. Limited pressure range.
Agilent 1290 or 1260 Infinity II Multisampler without Multiwash Option or with Dual-Needle Option (G7167B or G7167A)	Replace the FEP wash solvent line from the peristaltic pump to the wash port with longer PEEK tubing from the multiwash tubing kit (remove the bigger nut and stick the end of the PEEK tubing directly into the peristaltic pump tubing; secure with a compression spring (1460-2763), if available). Replace the FEP wash solvent line connected to the peristaltic pump inlet with shorter PEEK tubing from the multiwash tubing kit (remove the steel screw and ferrule and stick the end of the PEEK tubing directly into the peristaltic pump tubing; secure with a compression spring (1460-2763), if available). Use a PP Union (5022-2155) to connect the bottle head assembly.	Potentially higher carryover. Limited pressure range (1260 Infinity II Multisamplers).
Agilent 1260 Infinity II Multisampler with Multiwash Option	Convert the module as described for the 1290 Infinity II Multisampler with multiwash option in "PFC-Free HPLC conversion kit - Installation and Use Instruction".	Limited pressure range.
Agilent 1290/1260 Infinity II Vial Samplers (G7129B/A)	Replace the FEP wash solvent line connected to the peristaltic pump inlet with shorter PEEK tubing from the multiwash tubing kit (remove the steel screw and ferrule and stick the end of the PEEK tubing directly into the peristaltic pump tubing; secure with a compression spring (1460-2763), if available). Use a PP Union (5022-2155) to connect the bottle head assembly. The other FEP solvent line from the peristaltic pump to the needle wash well cannot be replaced with PEEK (too stiff). *Alternative:* use wash vials to wash the needle.	Some background from the nonreplaceable FEP solvent line may occur. Lower needle wash efficiency, and therefore potentially higher carryover, when using wash vials as alternative.
1290 Infinity Autosampler (G4226A)	Replace the FEP wash solvent line connected to the peristaltic pump inlet with shorter PEEK tubing from the multiwash tubing kit (remove the steel screw and ferrule and stick the end of the PEEK tubing directly into the peristaltic pump tubing; secure with a compression spring (1460-2763), if available). Use a PP Union (5022-2155) to connect the bottle head assembly. *Alternative:* use wash vials to wash the needle.	The FEP solvent line from the peristaltic pump to the wash port cannot be replaced easily; some PFAS background may occur. Lower needle wash efficiency, and therefore potentially higher carryover, when using wash vials as alternative.
Older Autosamplers (G1367E etc.)	**DO NOT USE TEFZEL ROTOR SEALS** For wash solvent line replacement, see 1290 Infinity Autosampler (G4226A). *Alternative:* use wash vials to wash the needle.	The FEP solvent line from the peristaltic pump to the wash port cannot be replaced easily; some PFAS background may occur. Lower needle wash efficiency, and therefore potentially higher carryover, when using wash vials as alternative.

Ordering details

Kit and subassemblies

Part Number	Description
5004-0006	PFC-free LC conversion kit
5004-0005	PFC-free Sealwash Bottlehead Assembly, with silicone tubing
5004-0004	PFC-free Bottlehead Assembly, with polypropylene tubing
5004-0003	PFC-free multiwash tubing kit; tubing material: PEEK
Additional spare parts	
5062-8100	InfinityLab PFC delay column, 4.6 × 30 mm
5067-1602	InfinityLab Quick Change inline filter assembly
5067-1613	InfinityLab Quick Change filter disc, 4.6 mm id, 0.5 µm pore size, 5/pk
01018-60025	Stainless steel filter, solvent inlet, 12–14 µm
5067-6167	InfinityLab Quick Connect assembly, stainless steel, 0.17 mm × 150 mm
5500-1231	InfinityLab Quick Connect capillary, stainless steel 0.17 mm × 500 mm
5067-5965	InfinityLab Quick Connect LC fitting
5043-1190	InfinityLab venting valve with time strip
9301-6530	Sticker for solvent bottles (100/pk)
9301-6529	Identification silicone ring (8/pk with four different colors)
5043-1816	Solvent line label clip set
5191-8150	2 mL screw style clear polypropylene vial (100/pk)
5191-8151	Polypropylene cap with thin membrane polypropylene/silicone septa (100/pk)

References

1. Wang, Z. *et al.* A Never-Ending Story of Per- and Polyfluoroalkyl Substances (PFASs)? *Environ. Sci. Technol.* **2017**, *51(5)*, 2508–2518.
2. Rosenblum, L.; Wendelken, S. C. Method 533 Determination of Per- and Polyfluoroalkyl Substances in Drinking Water by Isotope Dilution Anion Exchange Solid Phase Extraction and Liquid Chromatography/Tendem Mass Spectrometry. U.S. *Environmental Protection Agency*, Washington, DC, **2019**.
3. Shoemaker, J.; Tettenhorst, D. Method 537.1 Determination of Selected Per- and Polyfluorinated Alkyl Substances in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). *U.S. Environmental Protection Agency*, Washington, DC, **2020**.
4. Method 8327 Per- and Polyfluoroalkyl Substances (PFAS) using External Standard Calibration and Multiple Reaction Monitoring (MRM) Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). *U.S. Environmental Protection Agency*, Washington, DC, **2019**.
5. ISO 21675:2019 Water quality — Determination of perfluoroalkyl and polyfluoroalkyl substances (PFAS) in water — Method using solid phase extraction and liquid chromatography-tandem mass spectrometry (LC/MS/MS)

*** PFC-free.** All parts in the kit's flow path (including vials and caps) use non-PFC materials that meet the required guideline; "non-detectable" as per the referenced methods within this documentation.

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