Application proof note | 003822

Combustion-IC

Screening of per- and polyfluoroalkyl substances (PFAS) in food contact materials: Utilizing a new combustion-ion chromatography system for total organic fluorine (TOF) analysis

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Keywords

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Introduction

Per- and polyfluoroalkyl substances (PFAS) have been intentionally added to food contact materials (FCM) for decades to confer grease and water repellency. PFAS are highly persistent, bioaccumulative, and toxic. Consequently, the use of PFAS in FCM presents significant concerns related to direct human exposure and environmental pollution at the end of their lifecycle.

In response to these concerns, twelve states in the United States have or will legislate the use of PFAS in food packaging due to the absence of federal action. For example, California has banned all plant fiber-based food packaging containing PFAS that are either intentionally added or present at levels exceeding 100 parts-per-million (ppm) total organic fluorine (TOF), effective January 1, 2023.

In Thermo Scientific Application Note AN003644, we developed a method to measure TOF in FCM using combustion-ion chromatography (C-IC).[1] This application proof note demonstrates the determination of TOF in FCM using an enhanced C-IC system. The Thermo Scientific™ Cindion™ C-IC System combines the Thermo Scientific™ Dionex™ Inuvion™ IC System, featuring reagent-free ion chromatography (RFIC™), with the Thermo Scientific™ Cindion™ Combustion/Absorption Module. The system is optimized for increased combustion efficiency by incorporating a z-fold combustion tube to introduce

oxygen at multiple points. As a result, the combustion tube and furnace are shorter, and combustion times are reduced. This also results in a smaller footprint, saving valuable bench space. Additionally, the C-IC system is controlled by a single software, the Thermo Scientific™ Chromeleon™ Chromatography Data System (CDS), enhancing data processing and system management efficiency.

Method

IC conditions

IC system:	Dionex Inuvion IC system with Thermo Scientific™ Dionex™ AS-AP Autosampler
Columns:	Thermo Scientific™ Dionex™ IonPac™ AS24 Analytical Column (2 x 250 mm) (P/N 064153) Thermo Scientific™ Dionex™ IonPac™ AG24 Guard Column (2 x 50 mm) (P/N 064151)
Eluent:	8 mM KOH from 0-6 min, 8-75 mM KOH from 6-9 min, 75 mM KOH from 9-12 min, 8 mM KOH from 12-20 min
Eluent source:	Thermo Scientific™ Dionex™ EGC 500 KOH Cartridge (P/N 075778) with Thermo Scientific™ Dionex™ CR-ATC 600 Continuously Regenerated Anion Trap Column (P/N 088662)
Flow rate:	0.3 mL/min
Injection volume:	25 µL
Column temperature:	30 °C
Detection:	Thermo Scientific™ Dionex™ ADRS 600 Anion Dynamically Regenerated Suppressor, 2 mm (P/N 088667), recycle mode, 56 mA current
Run time:	20 min

Combustion and absorption conditions

Combustion system:	Cindion combustion/absorption module		
Furnace temperature:	Heater 1:1050 °C, Heater 2: 1050 °C		
Gases:	Oxygen (primary): 300 mL/min Oxygen (turbo): 100 mL/min Argon carrier: 100 mL/min		
Absorption solution:	7 mL DI water		
Boat program:	Position (mm) 75 150	Wait time (s) 60 300	Boat speed (mm/s) 3 3

Sample analysis

In this study, TOF in samples S1-S3 from AN003644 was determined by subtracting the Total Inorganic Fluorine (TIF) from the Total Fluorine (TF). TF was measured using the combustion method, while TIF was determined by directly injecting water-extracted samples into the Ion Chromatograph (IC) using the Dionex AS-AP autosampler. Detailed setup instructions for the 2-in-1 system are provided in Technical Note TN003853.[2] Table 1 summarizes the results for the three samples, and Figure 1 presents one of the IC chromatograms for TF and TIF in sample #1.

Table 1. TOF in food contact material, ppm (µg/g) (n=3, RSD<8%)

Sample	TF	TIF	TOF (TF-TIF)
1	1089	0.42	1088.6
2	1346	0.29	1345.7
3	2151	0.20	2150.8

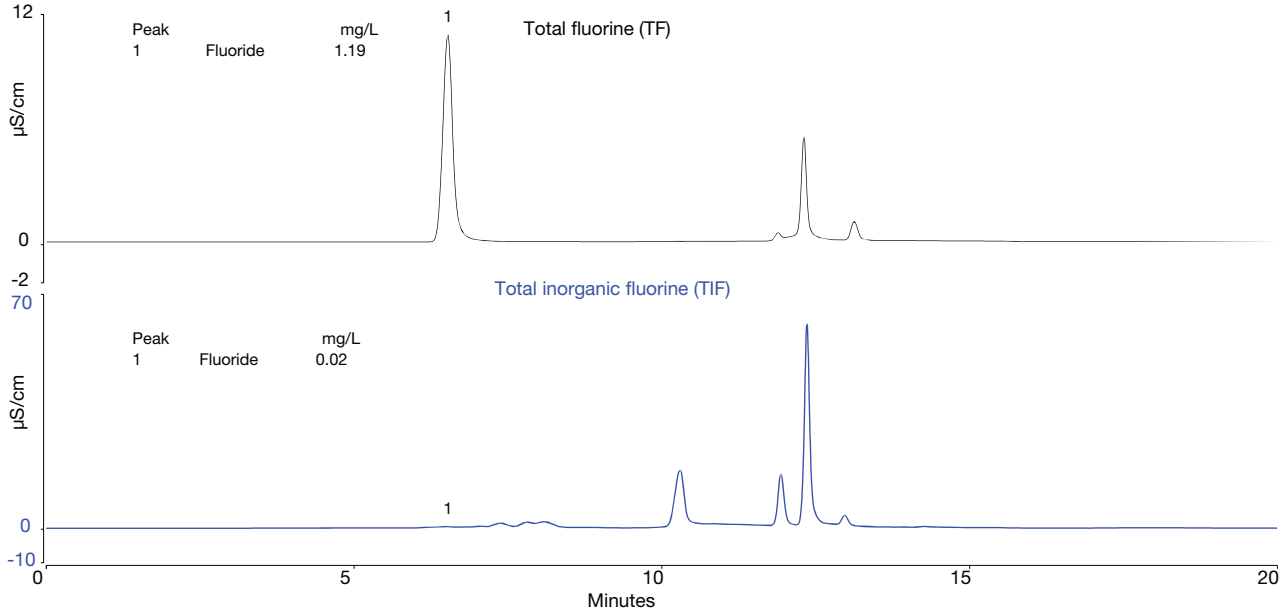

Figure 1. TF and TIF in sample #1 (Disposable paper plate).

Conclusion

The TOF results for the three samples (S1–S3) from AN003644 were closely aligned with the previous findings, with values that were 98% to 101% of those found in the application note. In AN003644, TIF was measured by directly injecting samples through four external injection channels, which required manual sample changes after every four analyses and large sample volumes. In contrast, the new C-IC system offers a versatile 2-in-1 configuration, allowing seamless switching between C-IC and standalone IC with the Dionex AS-AP autosampler. This configuration significantly improves efficiency and convenience. The TOF method provides a valuable tool for manufacturers to comply with current state regulations on PFAS in food contact materials.

References

1. Jingli Hu, Richard Cochran, Cynthia Grim, Neil Rumachik (2025) Application Note AN003644: Comprehensive screening of per- and polyfluoroalkyl substances (PFAS) in food contact materials; Utilizing combustion ion chromatography for total organic fluorine (TOF) analysis, Thermo Fisher Scientific, Sunnyvale, CA, USA. [Online] Comprehensive screening of per- and polyfluoroalkyl substances (PFAS) in food contact materials; Utilizing combustion ion chromatography for total organic fluorine (TOF) analysis
2. Jingli Hu, Neil Rumachik (2025) Technical Note TN003853: Configuring the Thermo Scientific Cindion C-IC system for a 2-in-1 operation: Seamless switching between combustion-IC and standalone IC with an AS-AP autosampler, Thermo Fisher Scientific, Sunnyvale, CA, USA.

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