



Innovative Technique for Measuring Total Organic Fluoride by Direct-Injection Combustion Ion Chromatography

Wastewater

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Until now, analysis of **targeted** PFAS has seemed sufficient to assessing the environmental impact...

However, increasing interest from regulatory agencies, and science and technology leaders that Total Organic Fluorine (TOF) is necessary to understand the true impact.

As a result, an improved approach to analysis is needed...

Why is PFAS Monitoring Important?

Exposure to PFAS has adverse health effects



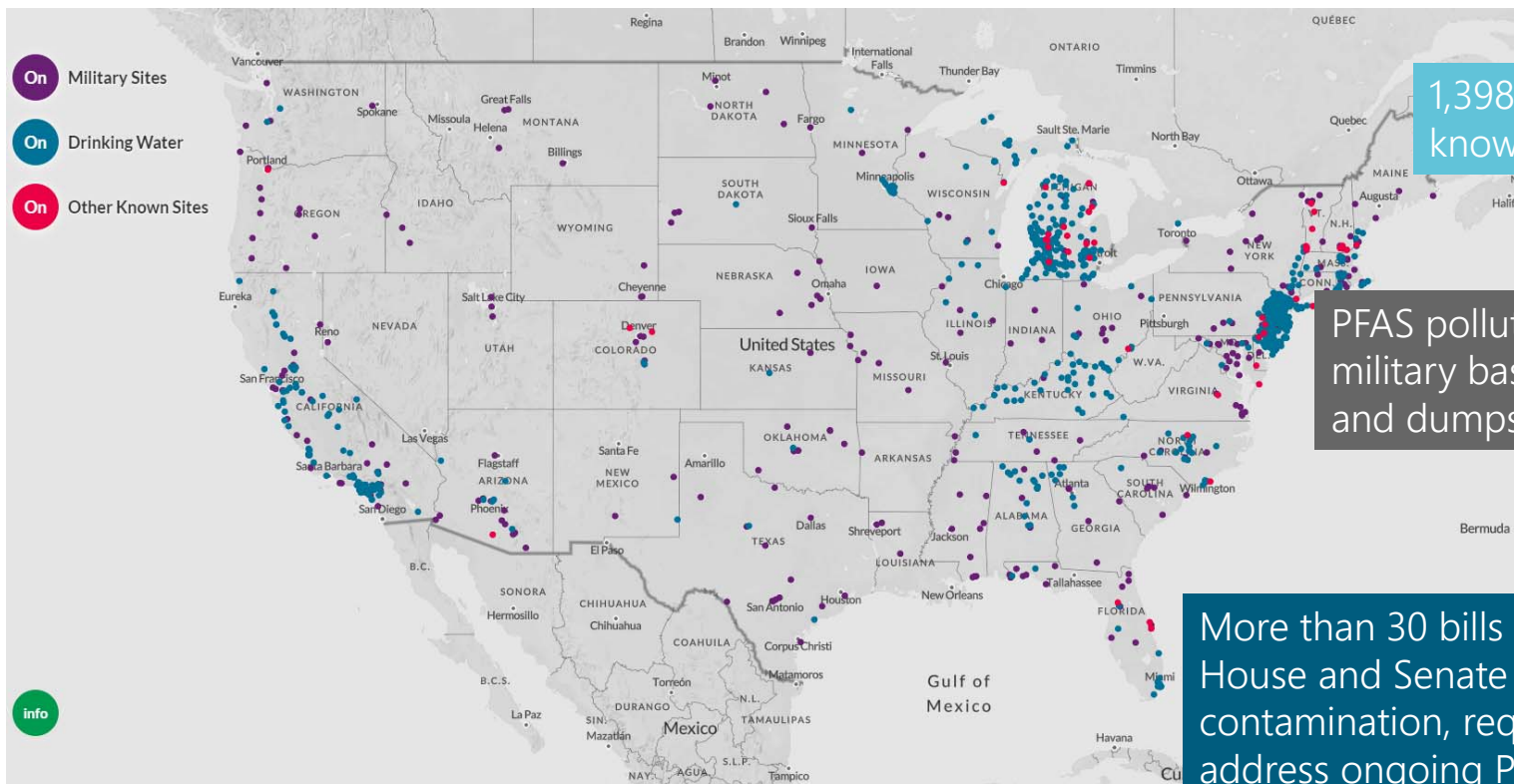
Over 4,000 different compounds identified

PFAS are persistent and accumulate in human body of long periods of exposure:

- Increased risk of cancer
- Abnormal development
- Disruption of immune systems



PFAS Footprint & Impact



1,398 locations in 49 states are known to be affected

PFAS pollution in public water systems and military bases, airports, industrial plants and dumps, and firefighter training sites

More than 30 bills have been introduced in the House and Senate to monitor the scope of PFAS contamination, require reporting of PFAS releases, address ongoing PFAS contamination, and clean up legacy PFAS pollution

https://www.ewg.org/interactive-maps/2019_pfas_contamination/

Move from Individual PFAS Quantification to Total Concentration of Total Organic Fluorine

Common targeted techniques such as LC-MS/MS and Total Oxidizable Precursor (TOP) Assay:

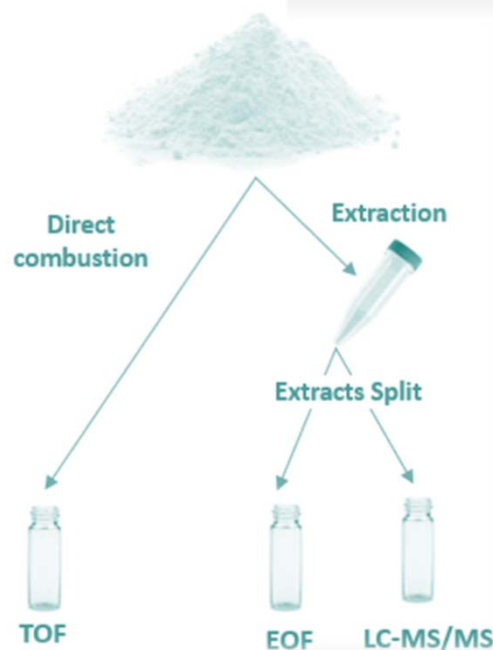
- Measure a limited set of targeted chemicals and precursors (< 1%) with high sensitivity
- Fail to identify all PFAS compounds
- Unable to determine the full extent of PFAS contamination

Current Analytical Practices in the Marketplace

AOF= Adsorbable Organic Fluorine

Capture and Combust Technique

- The sample is passed through a media that adsorbs the PFAS compounds (most commonly activated charcoal)
- Activated charcoal is now burnt through CIC (wood/nature or biological) common technique



EOF = Extractable Organic Fluoride

Capture and Elute Technique

- Used as prep for LC-MS for compliance to regulatory methods such as EPA 537.1

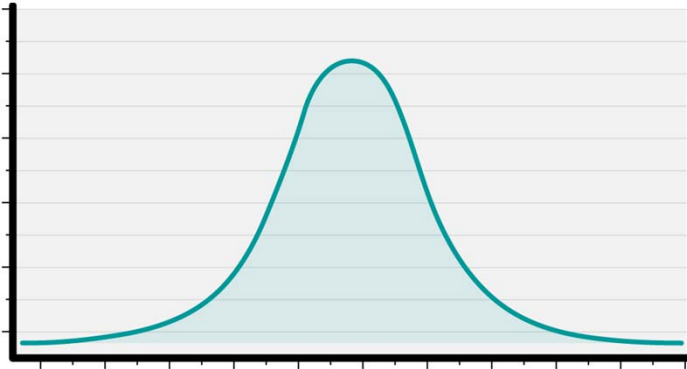
Assumption is that the outcome of AOF or EOF = Total Organic Fluorine (TOF)
How do you know you are capturing everything?

Limitations of LC/MS Techniques

Identifies only a small fraction of Total PFAS

Quantifies an even smaller fraction of PFAS compounds with MS standards

Does not determine the total fluoride or organic fluoride, the indicator of overall impact



Analyte	Recovery WW	LLOQ (ppb)	% CV
PFBS	72%	2	13%
PFHxS	85%	5	16%
PFOS	79%	2	5%
PFBA	58%	10	34%
PFOA	83%	2	12%
PFNA	79%	2	7%

Regulatory Goals & Objectives

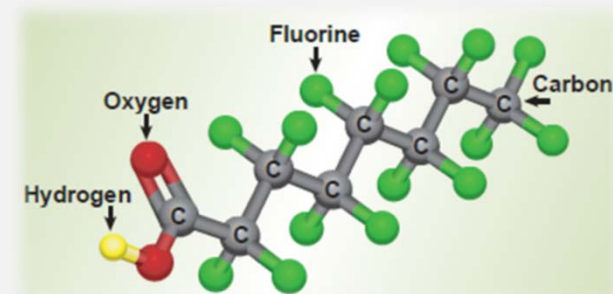


Issues related to PFAS involve most EPA Programs & Regions with four broad goals:

- Fill data gaps related to human health and toxicity to inform public concerns and risk mitigation
- Establish validated methods for measuring many PFAS in different media
- Reduce environmental exposures
- Assure accurate and timely risk communications

Increased environmental focus on fluorine and fluorinated compounds:

- Imperative to understand migration of fluorine in the environment
- Urgent need to understand total fluorine quickly



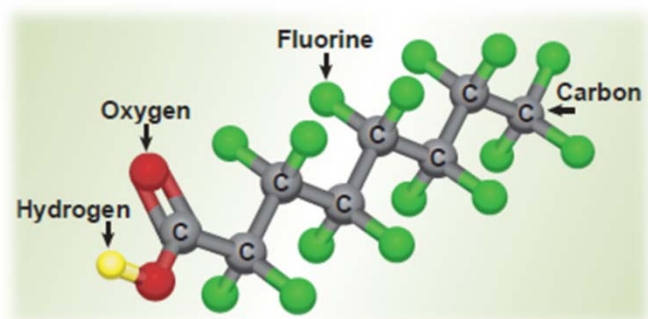


KNOW THE FULL SCOPE OF INORGANIC FLUORIDE AND ORGANIC FLUORINE

Profiler^F goes beyond measuring a limited set of compounds:

- Complimenting LC/MS, Profiler^F empowers measurement of complete fluorine profile
- Quantifies all fluorine, both covalently bound organic fluoride and inorganic and free fluorine in solution
- Helps you prepare for future regulatory compliance/monitoring

Innovative Analytical Technique



Profiler^F
Liberate organically
bound Fluorine

Total Fluoride concentration from liberated
organically bound ion and free fluoride ion
in solution

Total Fluorine is
measured by
combustion

Total Fluorine is the
sum of organically
bound fluorine and
free fluoride ion

Free fluoride ion is
measured
simultaneously by
traditional IC

Total Organic
Fluorine measured
by subtraction

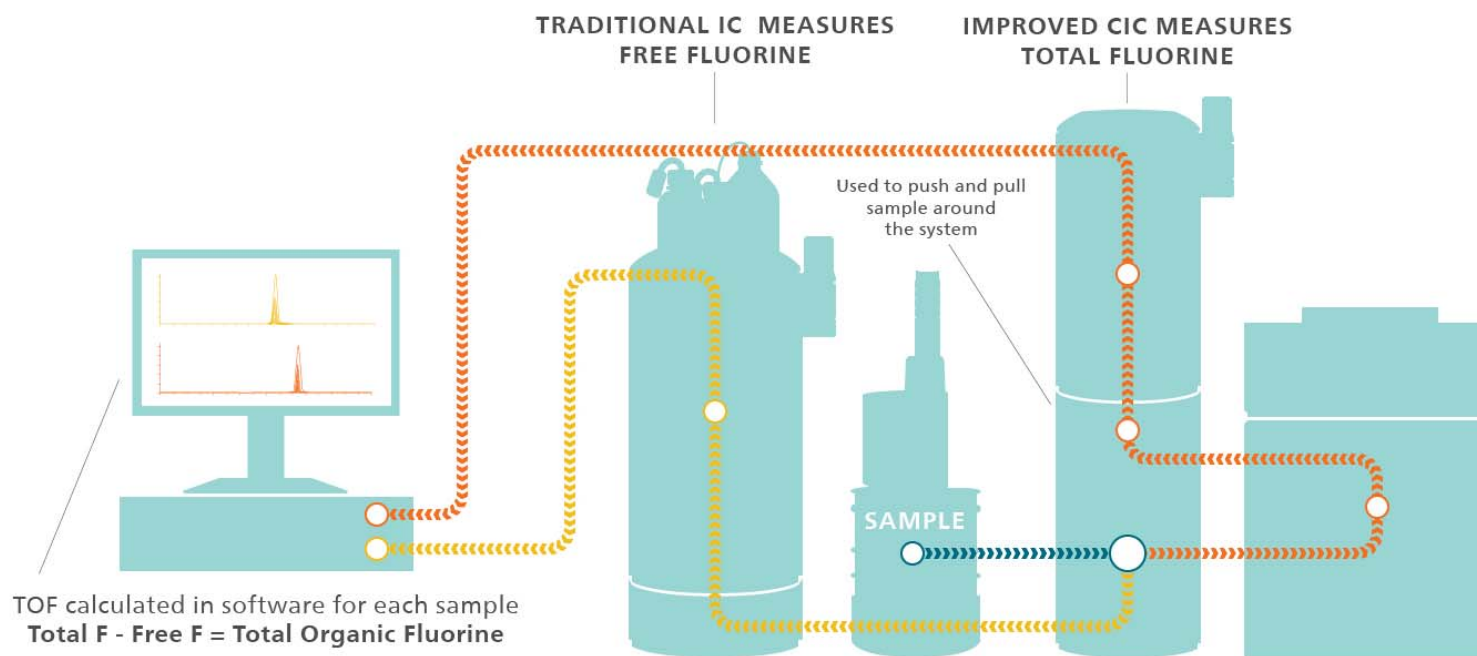
Profiler^F

TOTAL FLUORINE ANALYZER



How it Works

The system takes a single liquid sample and completes both a free fluoride analysis using direct IC and a total fluoride analysis incorporating proprietary combustion technology.



$$\text{Total Fluorine} = \text{Total Organic Fluoride} + \text{Free Fluorine}$$

Capture the Complete Profile



Total Fluorine

Free Fluoride

Total Organic Fluorine (TOF)

Configuration Parameters:

- Most tap water has 0.5 to 1 ppm free fluoride background from city treatment
- Background from free fluoride and other ions determines the TOF measurement range and limit of detection.
- Dilution (manual), inline sample preparation, and variable sample injection volume can be used to widen the measurement range, as necessary

Reporting & Data Analysis

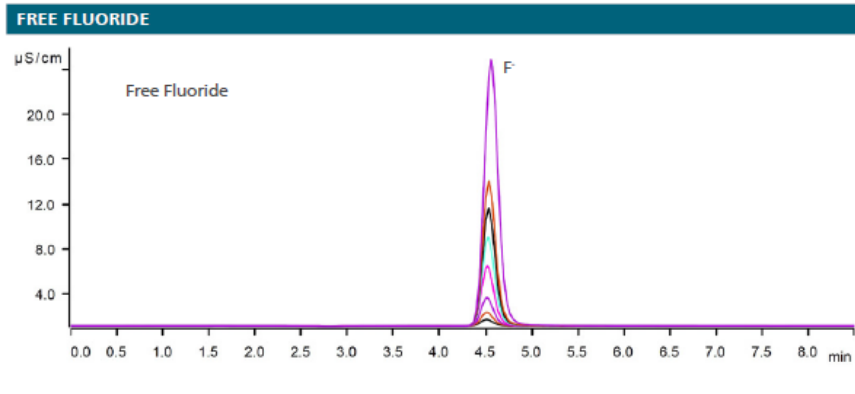
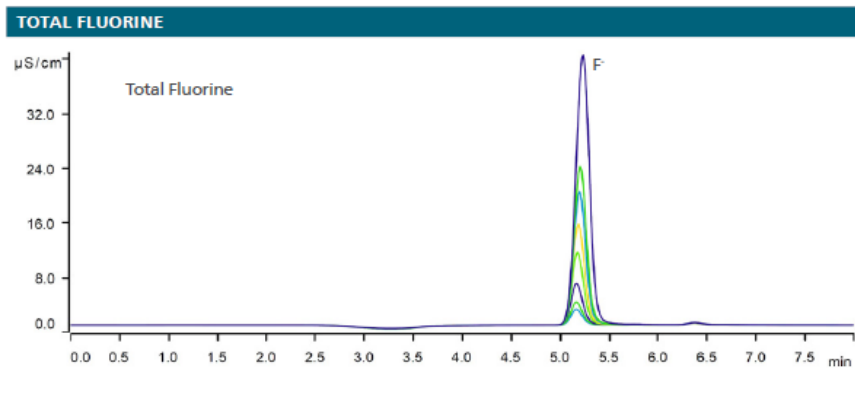


Figure 1.



- A single solution is used as a standard to calibrate both TF and FF
- Free Fluoride and Total Fluorine peak areas are determined automatically on one software platform - MagIC Net
- Single report is issued detailing free fluoride and total fluoride
- Methods and results are designed for entry level chemists

Sample Prep Cartridges

Optional

IC-Ag Sample Prep Cartridge, 50 pieces



Removes Chloride

IC-H Sample Prep Cartridge, 50 pieces



Removes Cations

Real World Sample Data

Subset of Only 10 Samples

Sample description	LCMSMS Results (by IDMS)	Metrohm Profiler - F Total Organic Fluoride
(average of triplicate)	parts per billion (ppb)	
Real world Water Sample -1	0.0097	150
Real world Water Sample -2	0.0062	130
Real world Water Sample -3	0.8142	570
Real world Water Sample -4	2.586	370
Real world Water Sample -5	0	217
Real world Water Sample -6	2.8982	65
Real world Water Sample -7	0.0077	40
Real world Water Sample -8	0.2018	120
Real world Water Sample -9	0.2176	156
Real world Water Sample -10	0.0276	147

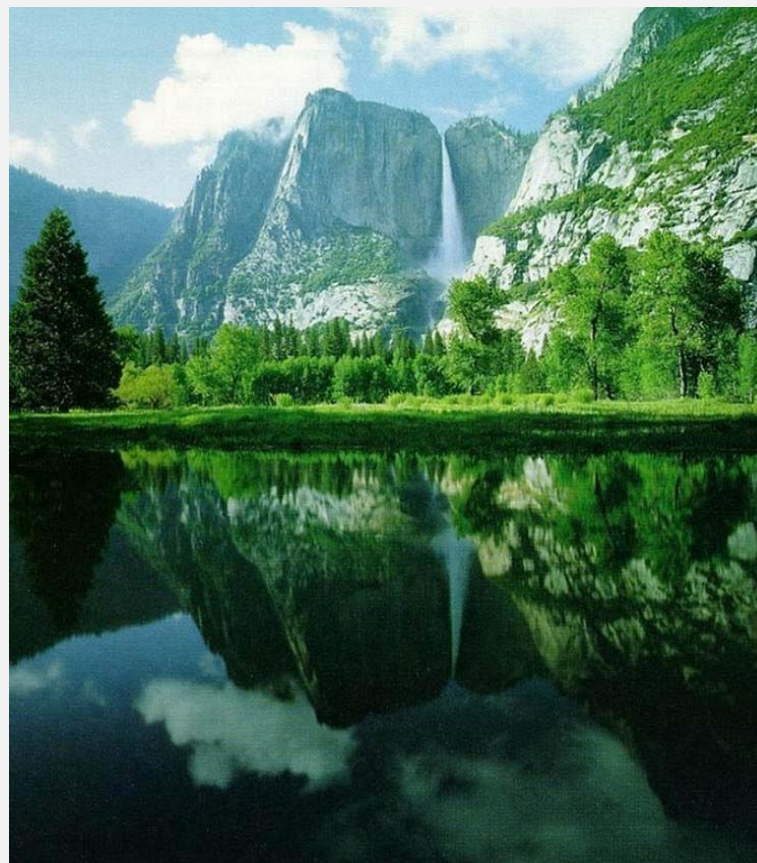
Every Single sample demonstrates higher Total Organic Fluoride ions compared to any other techniques in the market

Summary

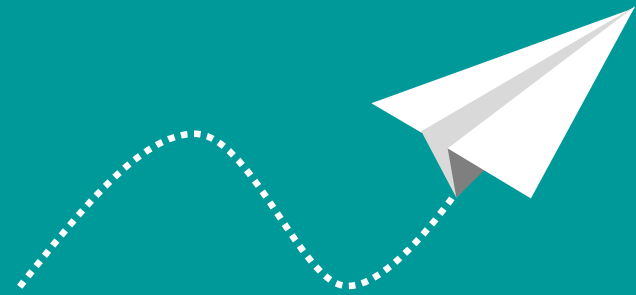
- Do not get misled by interchangeable terms of
 - AOF – Capture and Combust
 - EOF - Capture and Elute

AOF/EOF \neq TOF

- Profiler – F is a true “catch all” Total Fluoride analyzer
- Profiler – F is available in Solid sample configuration as well



Thank you!



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