PFAS Systems Engineering: Ion Exchange Uptake Mechanisms and Practical Design Considerations

Larry Gottlieb
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RESINTECH® INC.
INNOVATIONS IN ION EXCHANGE

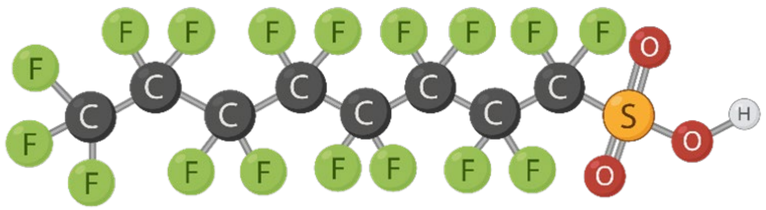
An American manufacturer of water treatment solutions.

PFAS Fundamentals – Chemistry and Naming

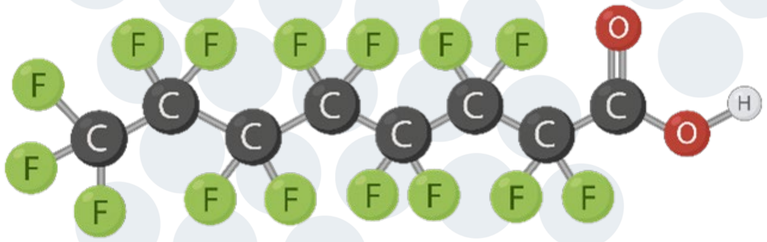
Anionic Tails: Sulfonic or Carboxylic Acids

# Carbons	Abbreviation	Name	Tail	Common Name's
3	Pr	PFPr	S/A	PFPrA
4	B	PFB	S/A	PFBS
5	Pe	PFPe	S/A	PFPeA
6	Hx	PFHx	S/A	PFHxA
7	Hp	PFPHp	S/A	PFPHpA
8	**O**	**PFO**	**S/A**	**PFOS / PFOA**
9	N	PFN	S/A	PFNA
10	D	PFD	S/A	PFDS

PFOS - Strong



PFOA - Weak



Why Ion Exchange?

Technology of Concentration

- Water / Wastewater / AFFF Treatment
- AIX Benefits - Higher Flow Rates
  - Common - 2-4 gpm/cf, EBCT 2-4 minutes
  - Uncommon – EBCT 20 Seconds
  - Uncommon – 20 minutes
- Single use resin
    - **No regeneration**
    - **No Backwashing**
- Special considerations needed for long life resin

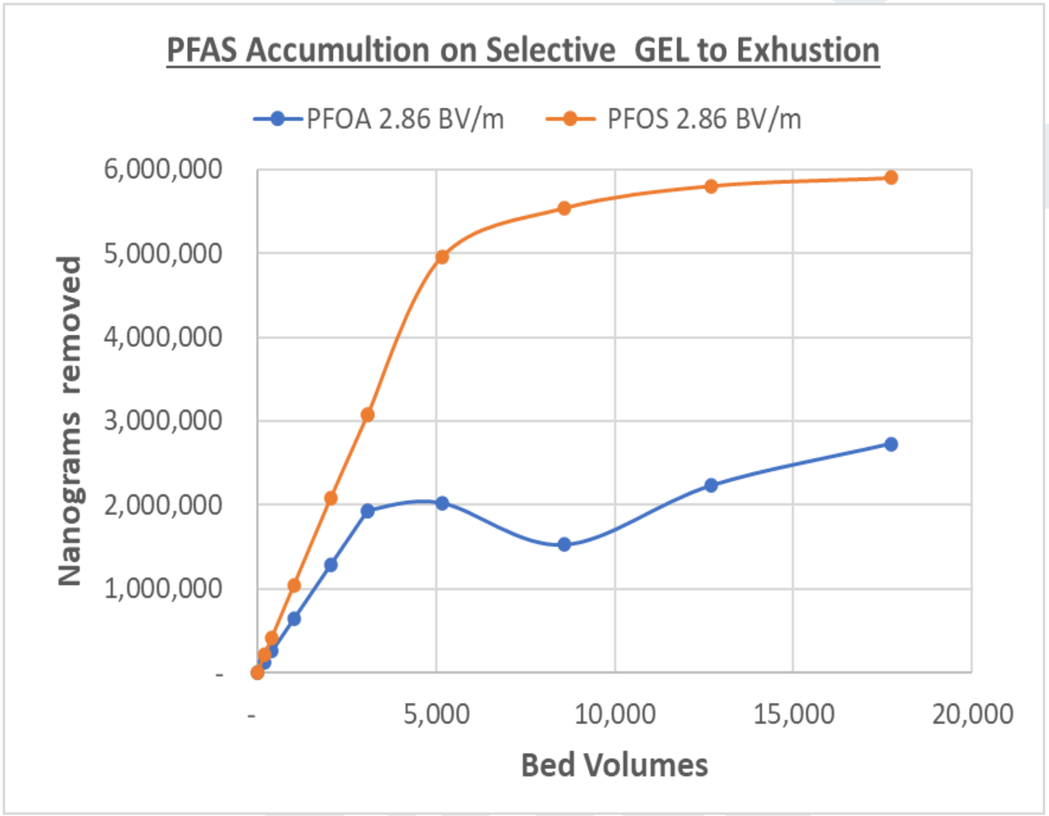
Ion Exchange Mechanisms For PFAS Uptake
Relatively Well Understood

- PFAS uptake performance in Ion Exchange Resins:
  - Influenced by Functional Group Chemistry (Strong/Weak Base)
  - Increasing Amino Carbon Chain Length Increases Selectivity
- Capacity Utilization:

PFOS Uptake Meq/ml	PFOA Uptake Meq/ml	Total Capacity Utilization %
0.02	0.007	5

- Tightly Bound!

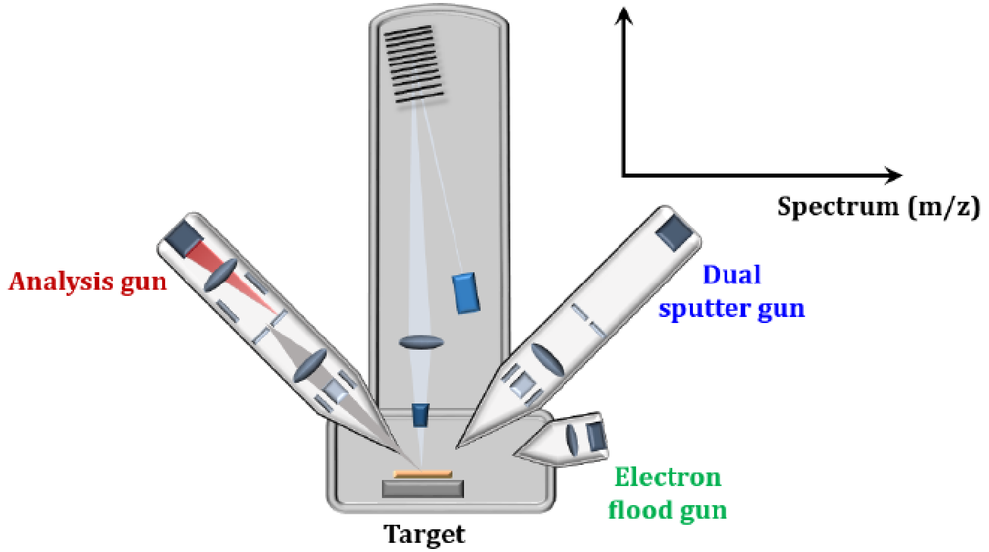
Species	PFOS	PFOA
Total Uptake(ng/kg)	33,037,882	67,314,089
Leachable Percent TCLP Protocol	0.07%	0.15%

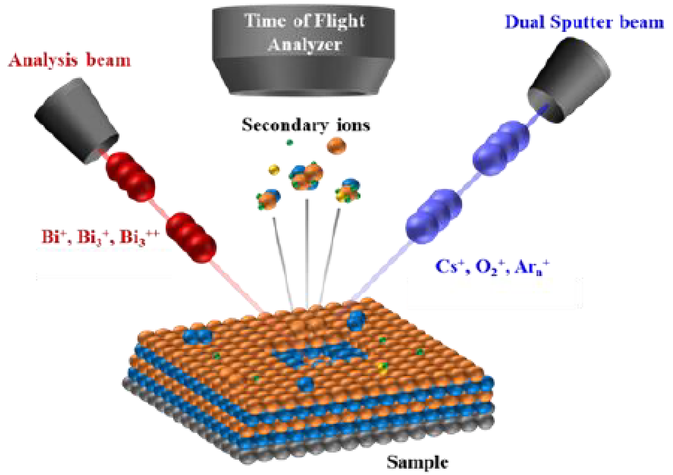


Time Of Flight SIMS

Surface Specific Technique
(Gives us Speciation and Qualitative Quantification

PRINCIPLE OF TOF-SIMS



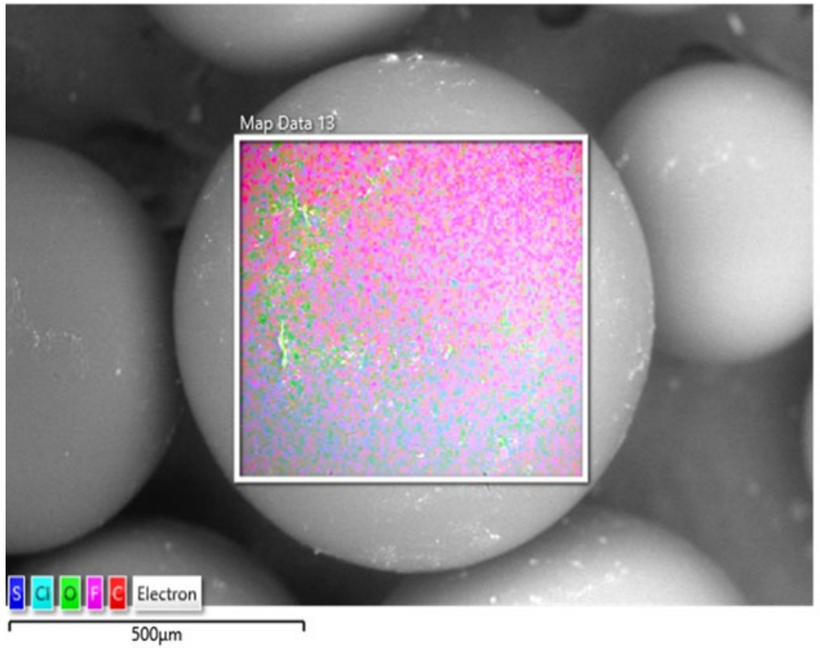


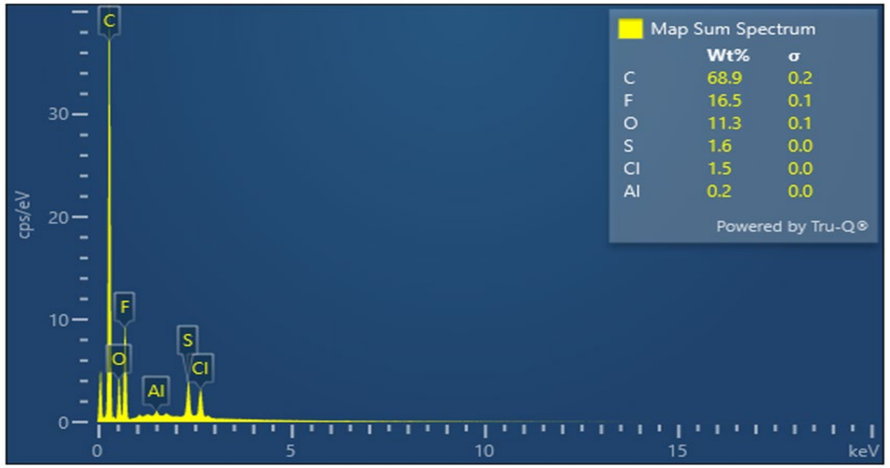
- ToF-SIMS analysis consists to bombard a solid sample surface with a pulsed primary ion beam
- Both atomic and molecular ions are emitted from the outermost layers of the surface. The ions are collected and analyzed with a time-of-flight detector. ToF-SIMS provides detailed elemental and molecular information about **surface**, **thin layers**, **interfaces**, and **full three-dimensional analysis** of the samples

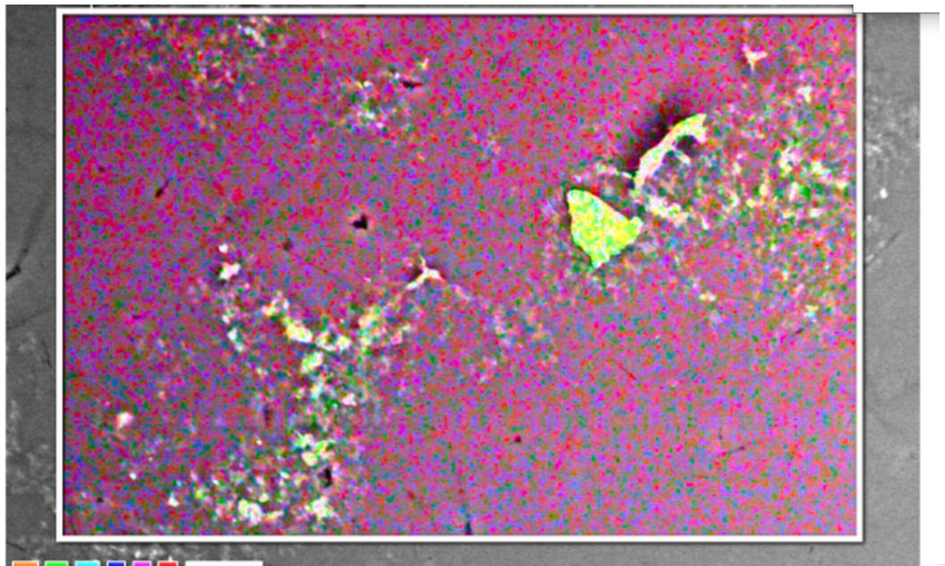
Solubility of PFAS Species

What Might Aggregation and/or Micellization Look Like

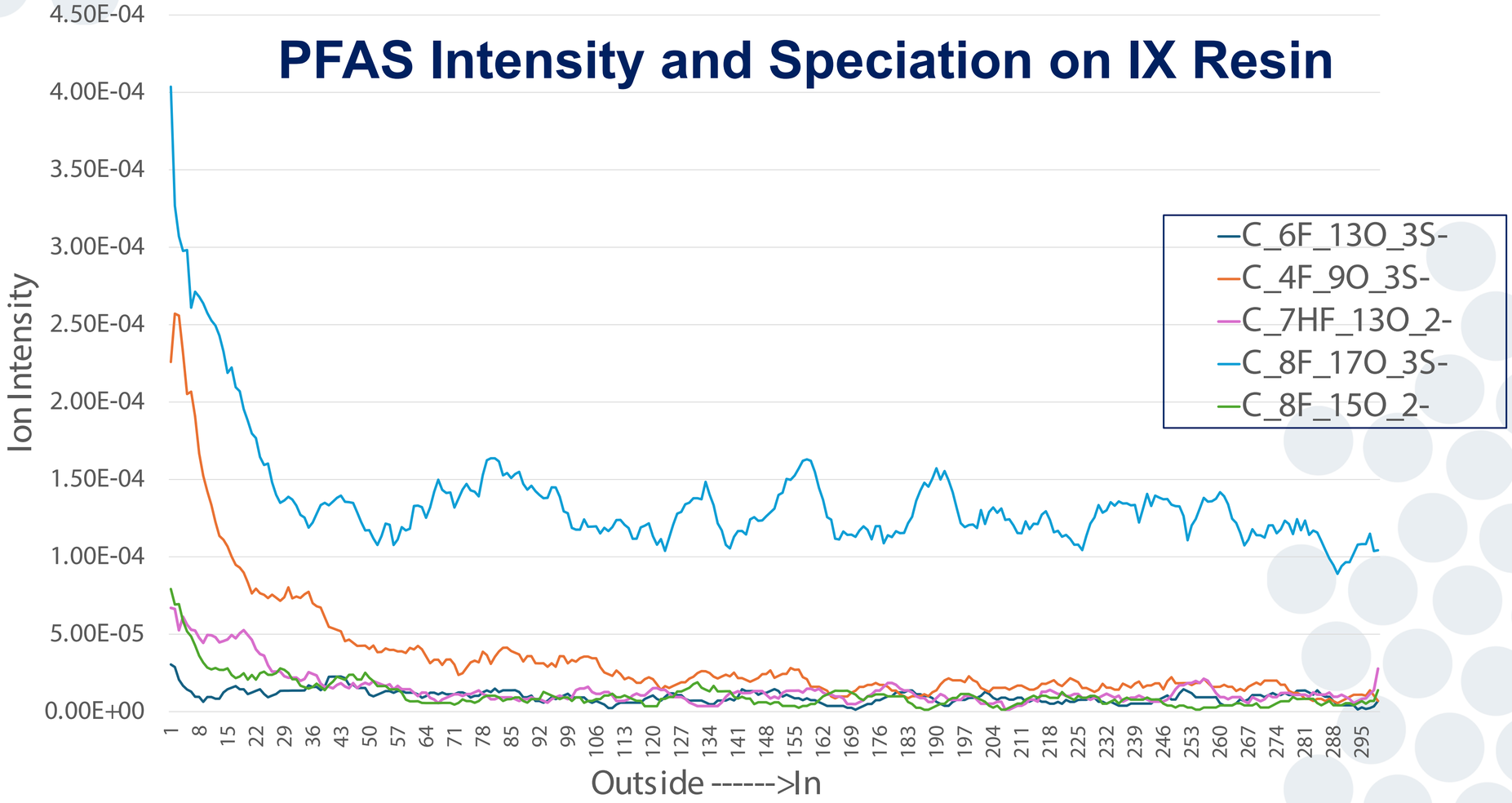
- Column Study Utilizing Early NSF Proposed PFAS Reduction Water







Depth Profiling –
Key Finding: PFAS concentrates at the surface
5-10% of IX Resin Diameter (400-600 Angstroms, Depth)



TOF SIMS Conclusions

New Perspectives on PFAS Uptake Mechanisms for IX Resins

Predominately a Strong Surface Component

Ion Exchange Occurring

Limited Interparticle Diffusion

- No Significant Capillary Trends (Interparticle)

Can Account for Surface Adsorption Component

- Lead Vessel PFOS, PFBS Surface Concentrations

New Perspective for Regeneration Approaches Beyond Solvents/Salt Solutions

PFAS System Design – Every System

Start with a Complete water analysis and Treatment Objective

- Inlet Conditions
- Applications details
- Operating Conditions
- Secondary Contaminants
- Anions / Metals
- Effluent Requirements
  - What are the Limits
  - Spent Media / Regeneration
  - Waste Treatment

PFAS Projection

Date: 4/14/2025

Company:	XYZ Company	**Contact Name**	Mr. Customer
Location	USA	**Contact Email**	mcstomer@XYZ.com
Project Name	Help me I have PFAS		

PRODUCT: SIR-110-HP

CATIONS	VALUE	UOM
Iron	0.01	ppm
Calcium	55.00	ppm
Magnesium	10.00	ppm
Potassium	6.00	ppm
Total Hardness	196.40	ppm as $CaCO_3$

ANIONS	VALUE	UOM
Nitrate (as NO3)	0.30	ppm
Sulfate (as SO4)	200.00	ppm
Chloride (as Cl)	100.00	ppm
Alkalinity	100.00	ppm as $CaCO_3$

PFCs	VALUE	UOM
PFBS	3.23	ppt
PFHpA	6.16	ppt
PFHxS	3.28	ppt
PFNA	1.71	ppt
PFDA	1.81	ppt
PFOS	22.90	ppt
PFOA	3.90	ppt
Total PFC's	42.99	ppt

PFAS Projections – Water / Waste Water

Endpoints dictate Operating Capacity

Flow Rate, Equipment Size and Water Quality must be considered

PFAS Projection Date: 4/14/2025

Company:	XYZ Company	**Contact Name**	Mr. Customer
Location	USA	**Contact Email**	mcstomer@XYZ.com
Project Name	Help me I have PFAS		

PRODUCT: SIR-110-HP

THROUGHPUT TO EPA LIMIT

PFCs	MCL (ppt)	BV	Gal/CF
PFBS	2000	1,009,416	7,550,431
PFHxS	10	1,258,504	9,413,609
PFNA	10	351,138	2,626,509
PFOS	4	276,061	2,064,940
PFOA	4	3,504,872	26,216,444

RECOMMENDATIONS

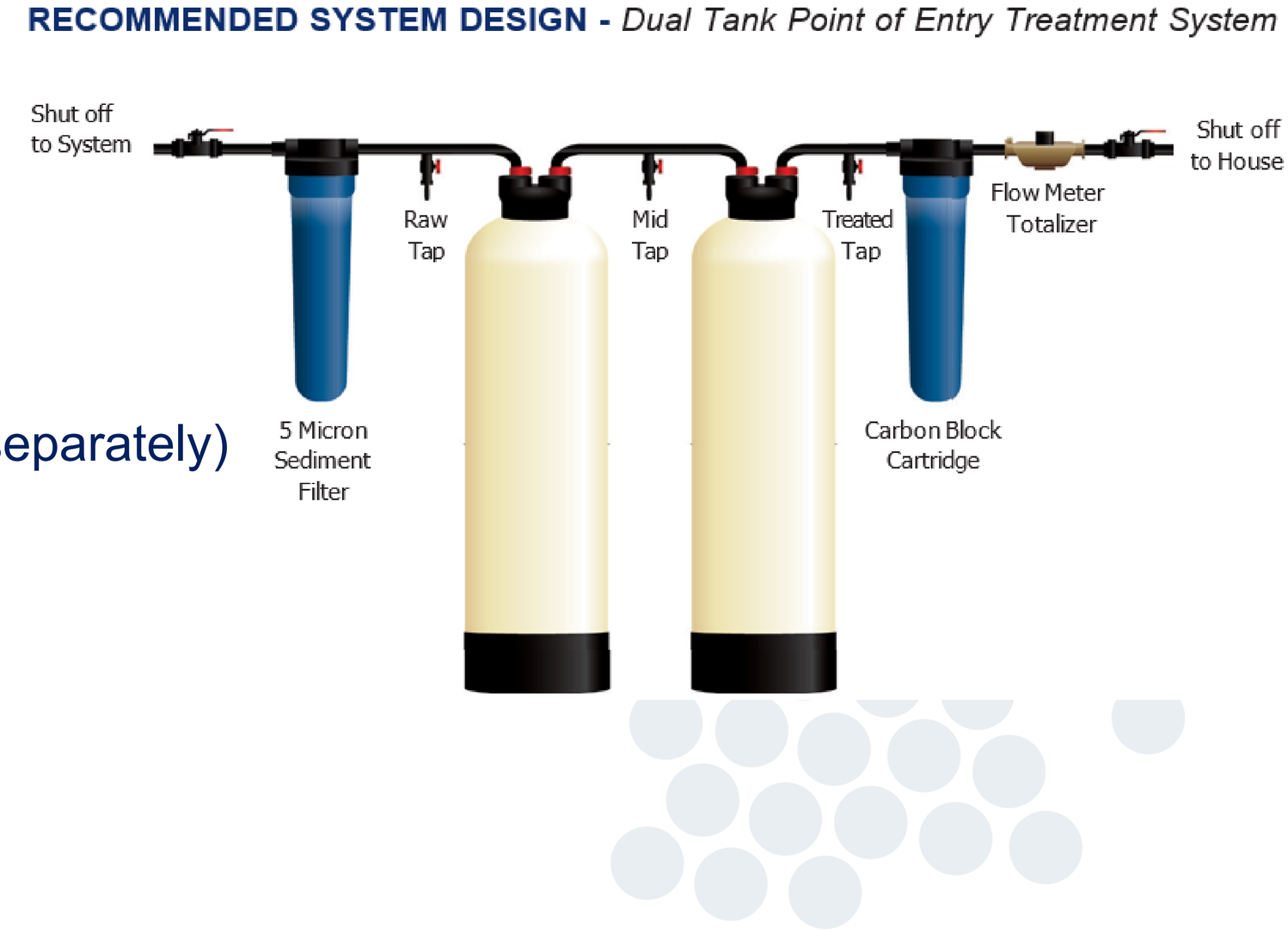
This water has over 10 grains of hardness and a softner is reccomended. Softening is always a good idea in from of a long life anion exchange unit. PFOS is the limiting factor in this water. A worker polisher set up will allow for the most efficient use of the primary AIX unit and wil insure PFAS Free water to the home,

What is the Endpoint?

POET – Household System Worker + Polisher

2 tanks, sample in between

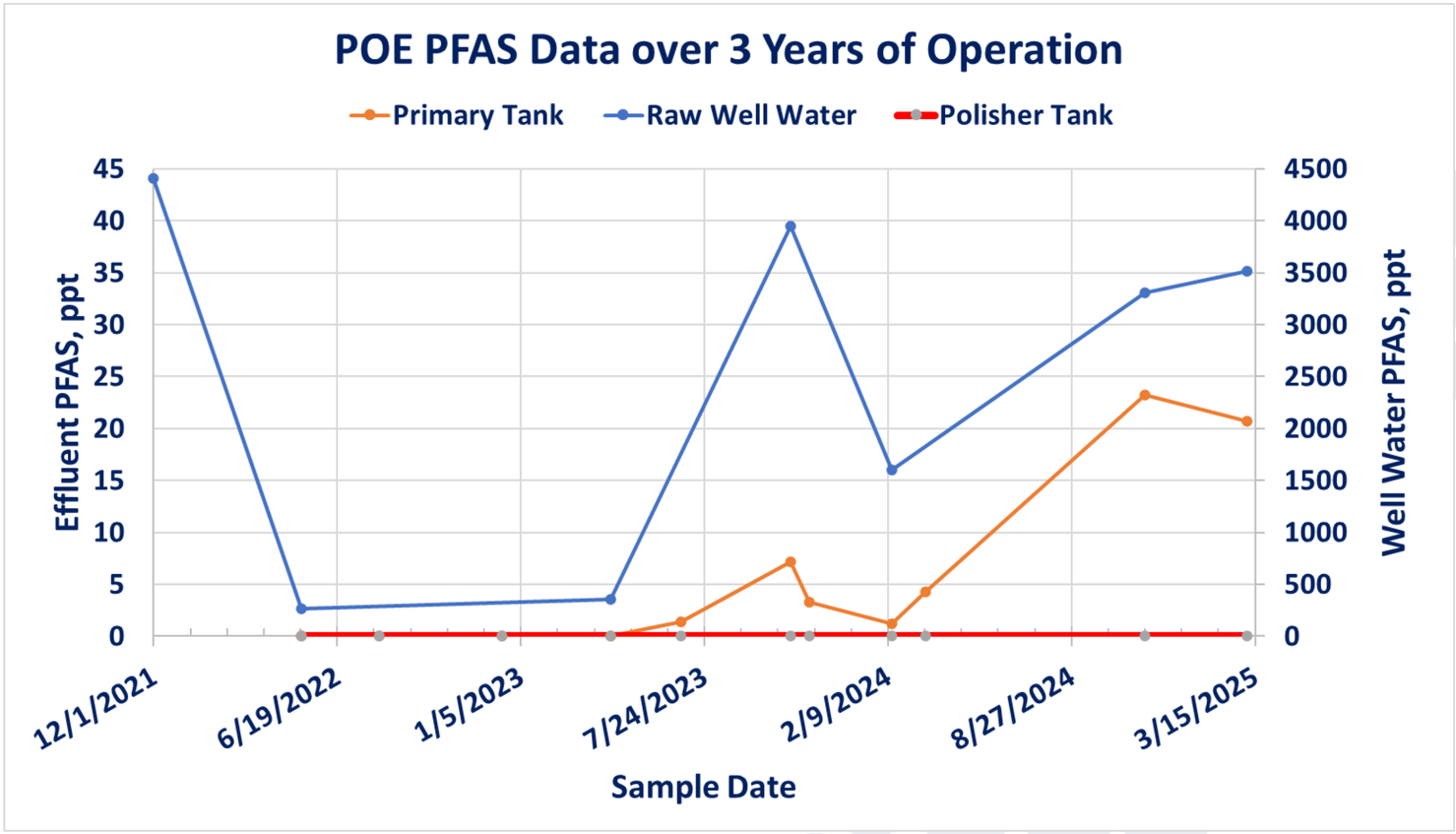
- Consists of:
  - 5 micron Pre filter
  - 2 Media Tanks
  - 3 sample ports
  - Carbon Block T&O
  - Flow Totalizer
- Other Contaminants? (handle separately)
  - Softener
  - Carbon
  - UV
  - RO
  - Post Filter



POET System 3 years in service

- **Rymon Road, Washington Township, North Jersey**

- RAW Water, 269 to 4500+ ppt
- Primary Tank 165,000 gallons
- 21 ppt, 99.3%
- Leakage increases with Load
- Polisher Tank – Non Detect
- Polisher Tank Moved to Woker Position
- No PFAS going to the house



POU AIX Filters

PFAS Point of Use Filters

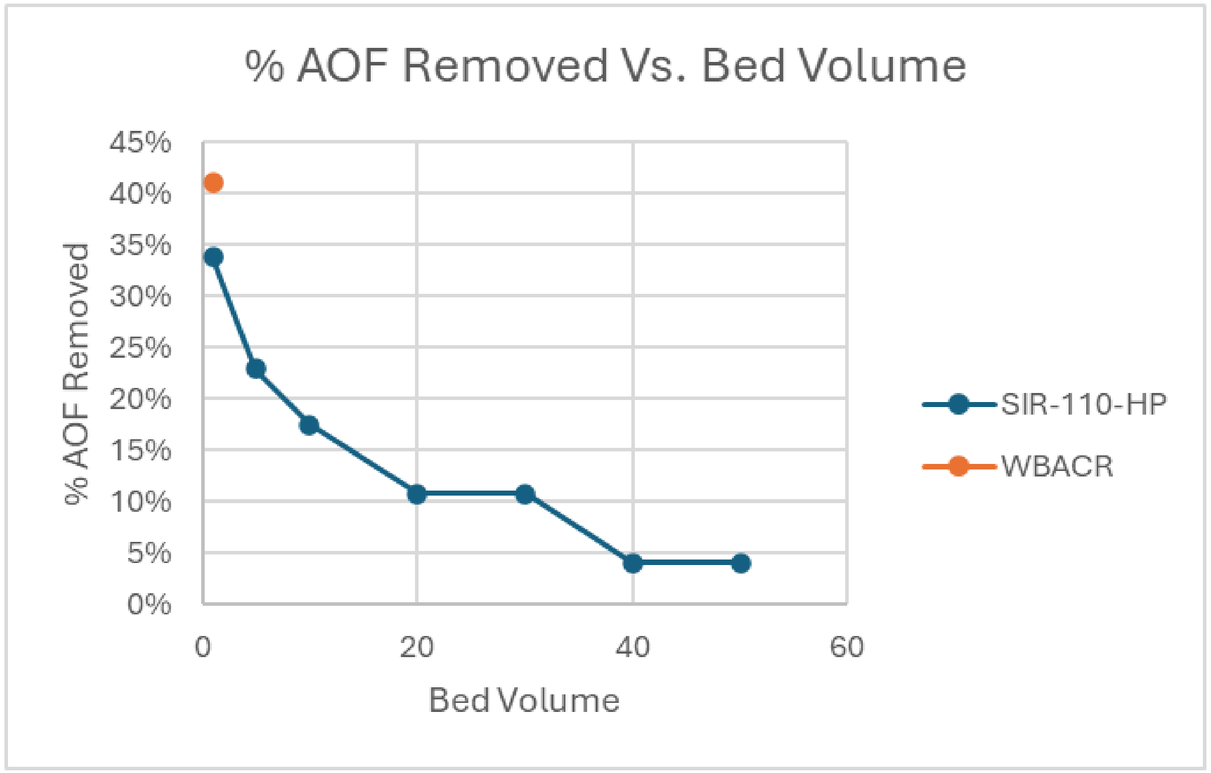
- The smallest, most demanding application
- Packs a lot of technology
- Short beds, 10 to 20 inches
- Fast Flow Rates
  - 18 + gallons per minute per cuft
  - Empty bed contact time of 24 secs!
  - 2.5 bed volumes per minute

Filter Cartridges AF-XX-3612
Aries Pro Series drop-in style cartridges utilize ResinTech PFAS selective media. They are sized to fit standard slimline and Big Blue housings.

AFFF Direct Treatment – Applying POU Filters

Feed Mayonnaise directly to Tuna Fish

- 20-minute EBCT
- Concentrate for Disposal/ Destruction
- AOF for analysis



We Still are at the beginning of PFAS

Changing Regulations

New AIX Resins / Functional Groups

Practical Regeneration Scenarios

Thank You & Questions?

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www.resintech.com

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