

Effective, Sustainable PFAS Water Treatment: Regenerable Ion Exchange Resin



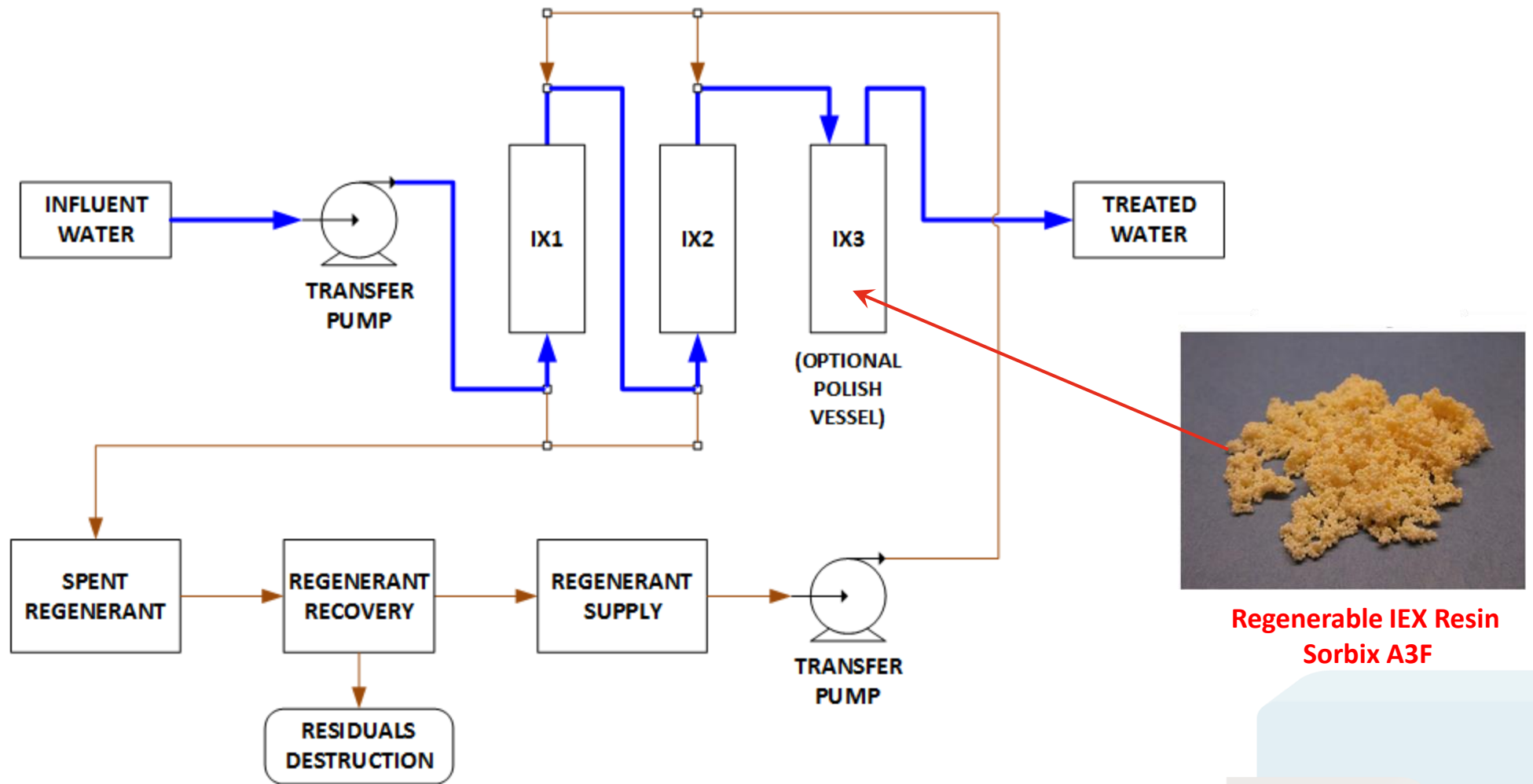
Steve Woodard, Ph.D., P.E.



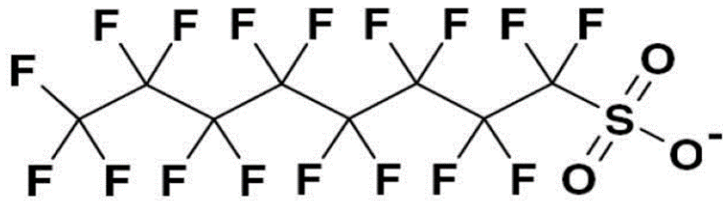
Outline

- How does ion exchange (IEX) resin remove PFAS?
- How does it get installed?
- What are the significant technology benefits?
- Performance data
- EBCT and other important parameters
- Residuals handling

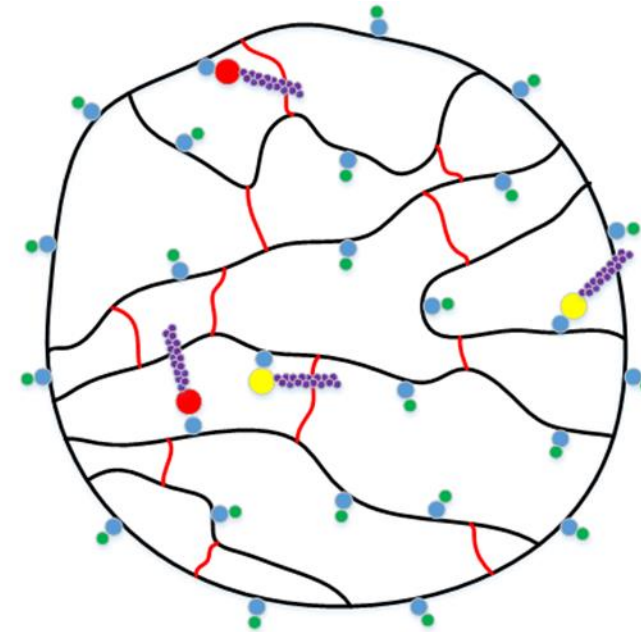
How does IEX resin remove PFAS?



Dual mechanism of removal: IEX and adsorption



PFOS Molecule



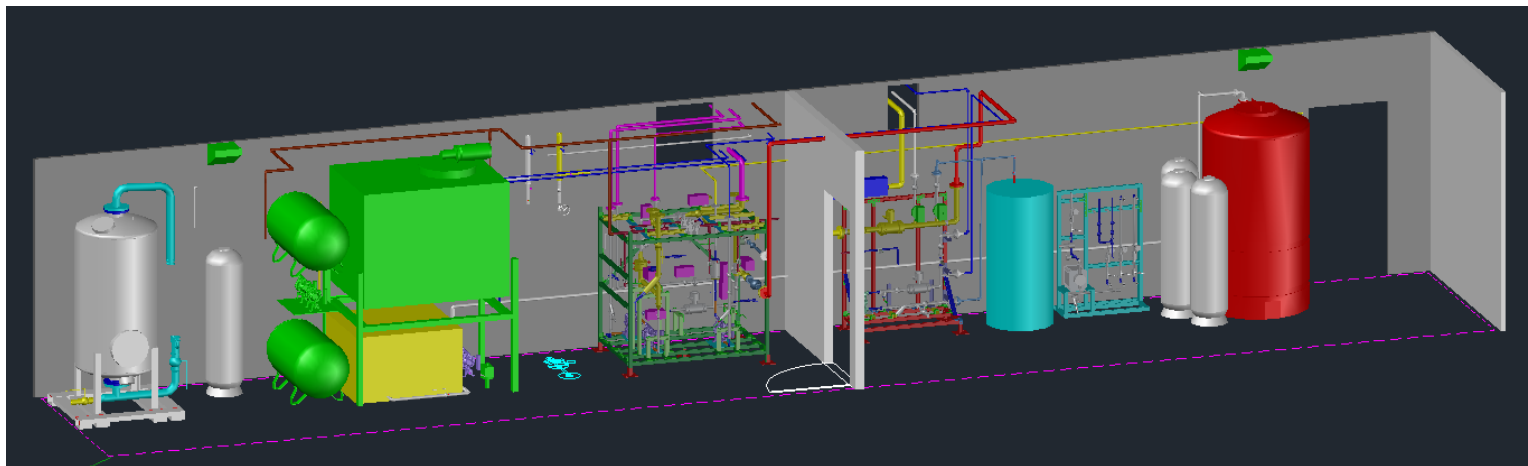
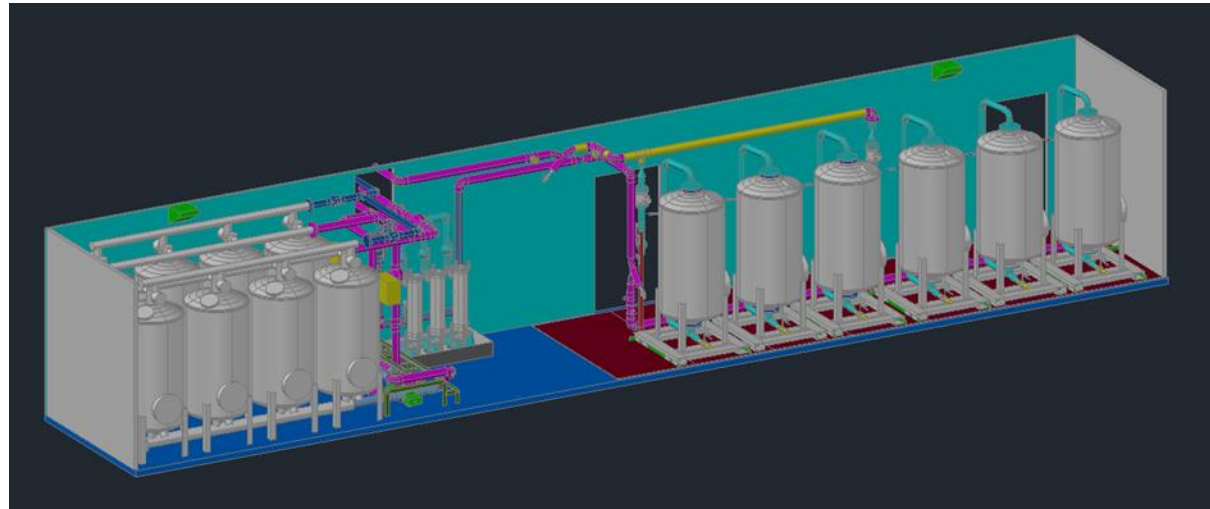
Simplified Resin Bead

-  Polystyrene polymer chain
-  Divinylbenzene crosslink
-  Fixed ion exchange group, e.g., quaternary ammonium, $\text{--}\text{N}^+$, for anion IEX
-  Exchangeable counter ion, e.g., chloride ion, Cl^- , for anion IEX
-  Sulfonate group, $\text{--}\text{SO}_3^-$, of PFAS (e.g., PFOS), replacing exchangeable counter ion
-  Carboxylate group, $\text{--}\text{CO}_2^-$, of PFAS (e.g., PFOA), replacing exchangeable counter ion
-  PFAS carbon-fluorine tail adsorbing to polystyrene polymer chain or divinylbenzene crosslink via Van der Waals forces

How are the IEX treatment systems installed?



Resin vessels and centralized (proprietary) regen system



Public outcry is driving action



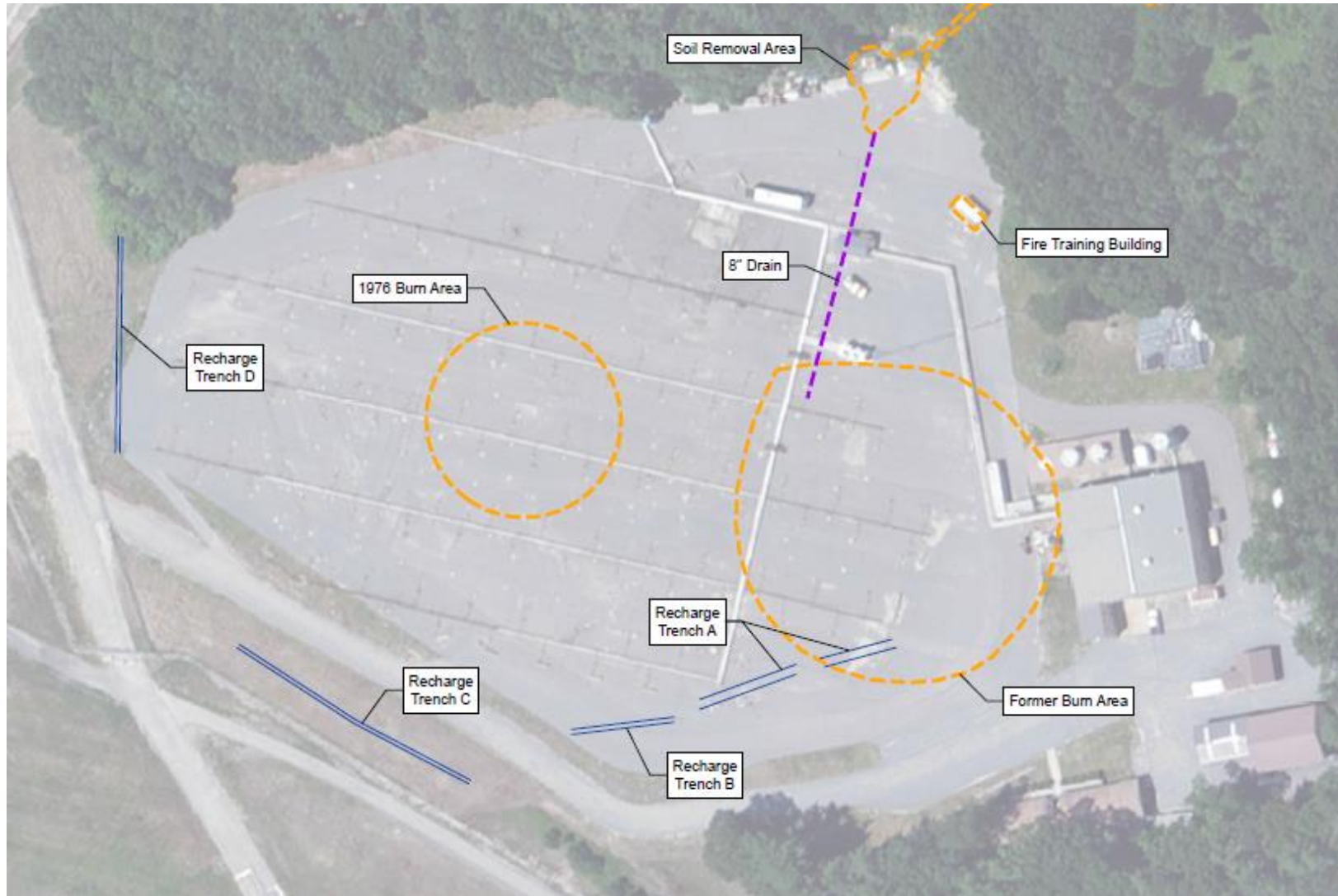
C-17 transport plane is delivering interim treatment systems to Australia



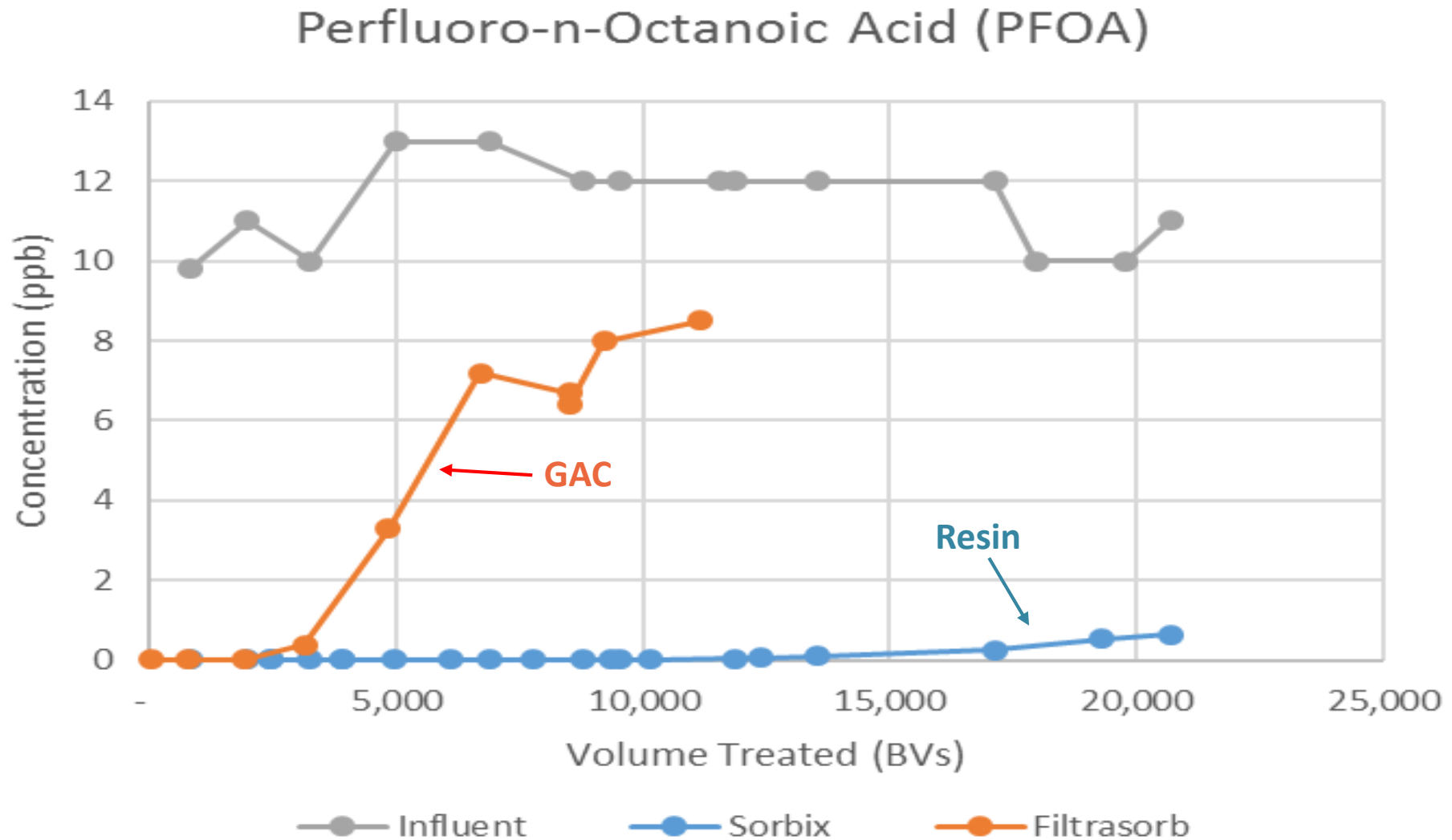
What are the significant technology benefits?

- **Dual mechanism** of removal takes advantage of unique properties of PFAS compounds
- **Capacity** is 5-6X **greater** than GAC for PFOA and > 8-10X greater for PFOS.
- **Kinetics** are **faster**, too, allowing use of smaller vessels
- Resin can be **regenerated in place** for reuse
- Distillation, ultra concentration and PFAS destruction maximize **sustainability**
- Exciting R&D in progress: **on-site PFAS destruction** in regenerant still bottoms
- Central regen and installation in shipping containers: compact, rapidly-deployable, mobile, cost-effective PFAS treatment process
- New resins are being tested successfully: e.g., effective removal of **shorter chain** compounds
- Unlike GAC, no pH or endotoxin issues
- Potential to effectively remove **cationic and zwitterionic** species

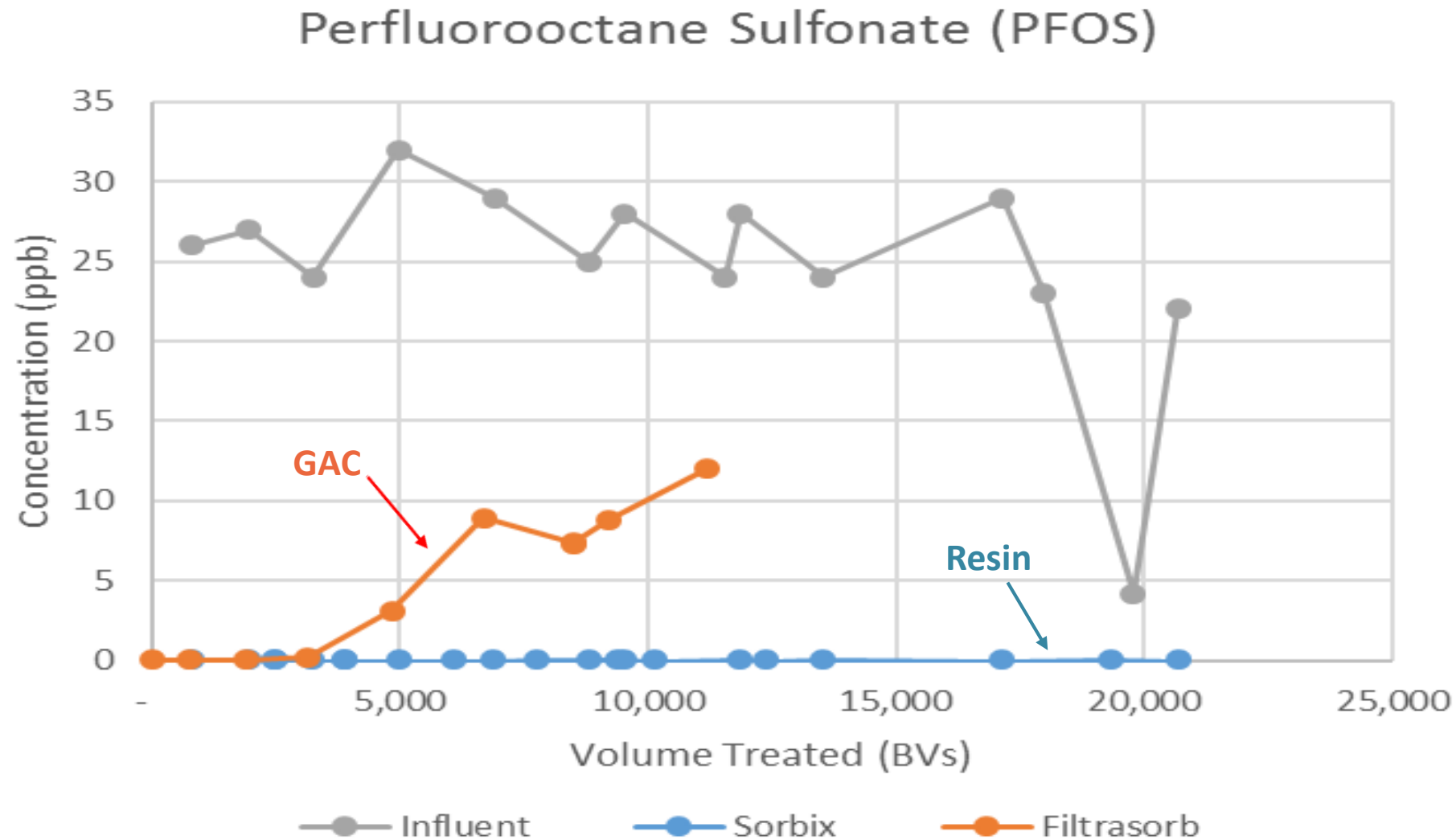
Side-by-side testing: IEX resin vs GAC



PFOA breakthrough at 5-min EBCT



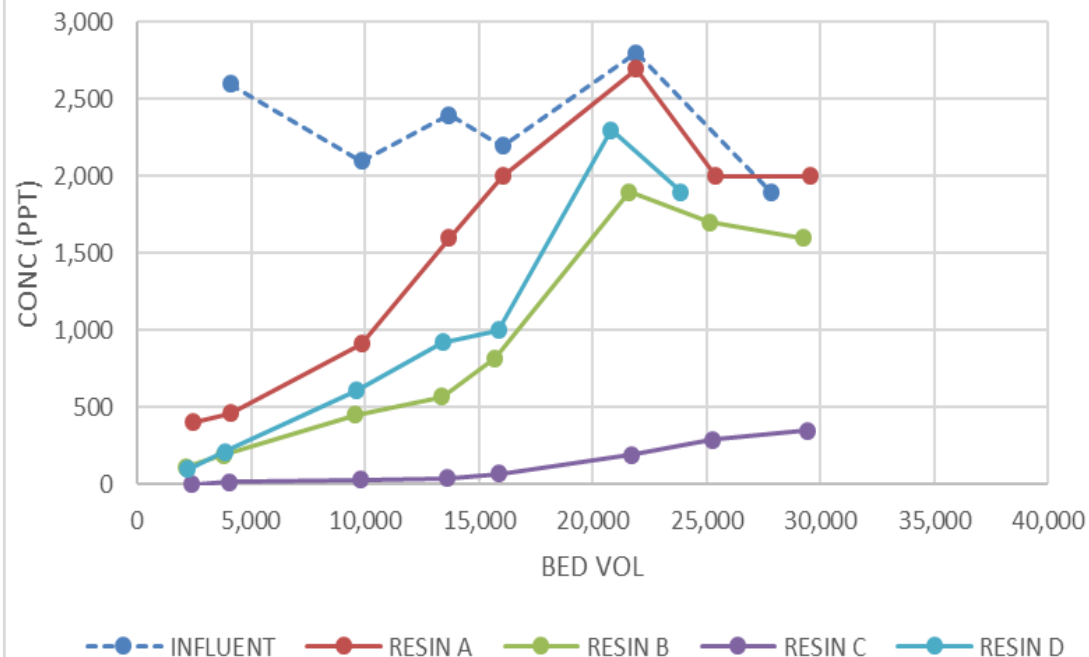
PFOS breakthrough at 5-min EBCT



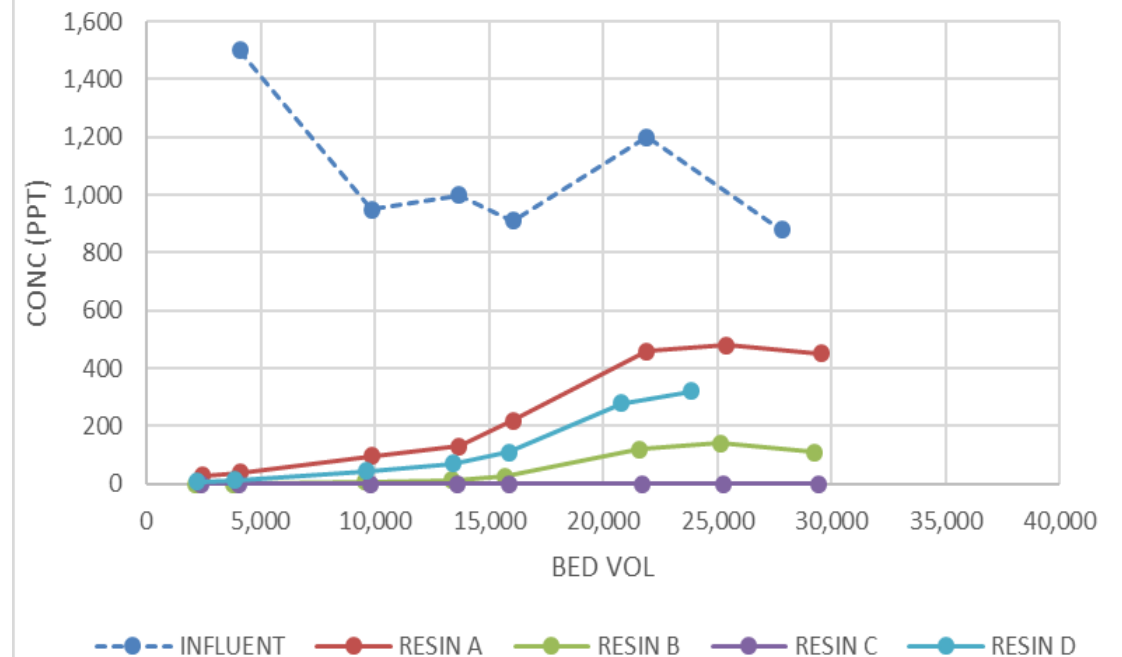
Very promising results for alternative resins:

Resin A = Sorbix A3F

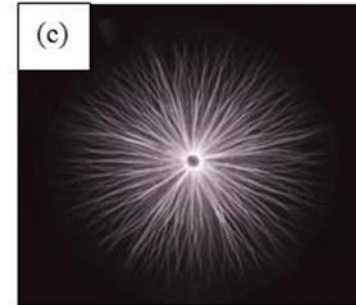
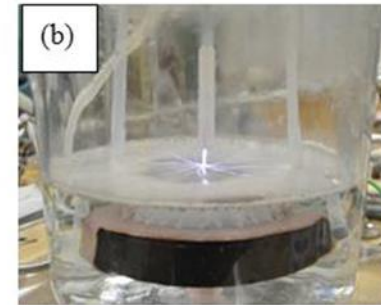
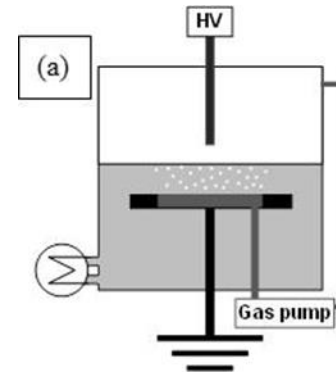
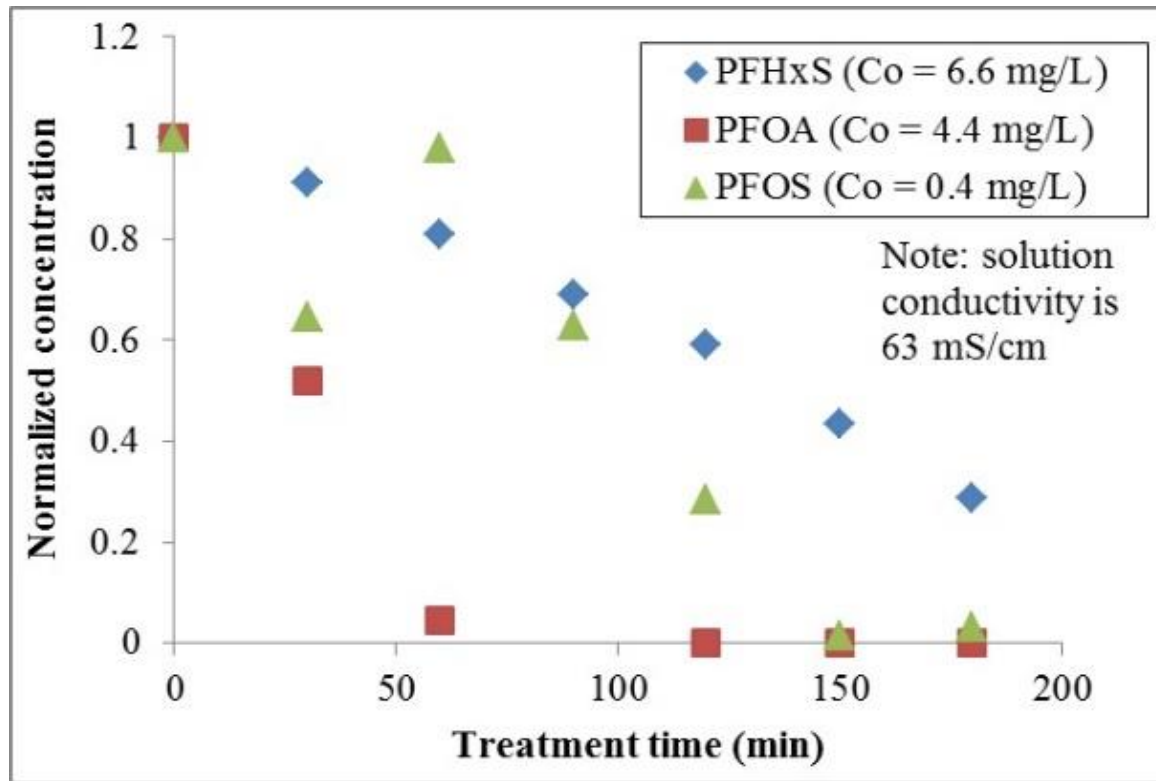
Perfluoro pentanoic acid (PFPeA)



Perfluoro heptanoic acid (PFHpA)



Residual management: successful destruction of PFAS compounds



PFAS removal from regen still bottoms using plasma treatment

Thank you!



Steve Woodard
(207) 210-1551
swoodard@ect2.com

