POSTER COMPETITION FINALIST

A Challenge for Full-Scale Prediction: Ion Exchange Resin Preparation Impacts Adsorption of Per- and Polyfluorinated Alkyl Substances (PFAS) during Rapid Small-Scale Column Tests (RSSCTs)

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Introduction

- Per-and polyfluoroalkyl substances (PFAS) are widely used in consumer products due to their chemical stability and surfactant properties.
- Exposure to PFAS through drinking water can pose variety of health risks.
- Approximately 45% of tap water in the U.S. contain at least one PFAS, necessitating treatment at an estimated 4,100–6,700 facilities to comply with new national drinking water standards established by the USEPA. [1]

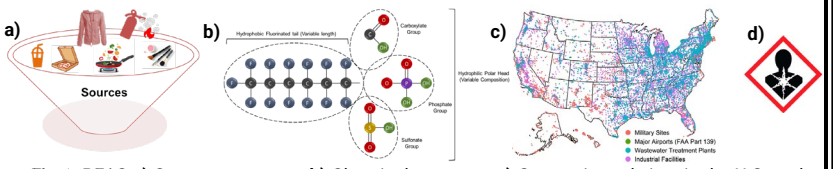


Fig 1. PFAS **a)** Common sources, **b)** Chemical structure, **c)** Contaminated sites in the U.S. and **d)** Health risks. [2],[3]

- Ion exchange (IX) resins are efficient, cost-effective, and eco-friendly for PFAS removal in Point-of-Use filters and Full-scale systems.
- Rapid small-scale column tests (RSSCTs) have been used as a time and cost-efficient method, utilizing smaller media and water volumes, to simulate the Pilot/Full-scale performance of IX.
- While grinding effects on activated carbon are studied, their impact on IX resin performance for PFAS removal is unexplored.

Objectives

The main objectives of this study are to:

(i) Evaluate the effect of grinding techniques on the adsorption of short and long chain PFAS (perfluorobutanoic acid [PFBA] and (perfluorooctanoic acid [PFOA]) in RSSCTs,

(ii) Investigate the role of material preparation on the Pilot scale prediction accuracy.

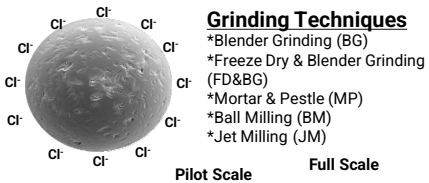
Materials and Methods

Experiment/Design Parameters	RSSCTs	Pilot-Scale Column
PFAS Types	PFBA (C4) and PFOA (C8)	
Resin Type	PFAS-Selective Ion Exchange Resin	
Resin Diameter (μm)	~100	~500
PFAS Concentration	50 mg/l	
Flow Rate (ml/min)	3.5	17.5
Empty Bed Contact Time (EBCT, min)	0.07	3.3
Adsorbent Mass (g)	0.26	93
Scaling Assumption	Constant Diffusivity	

Scaling Assumptions

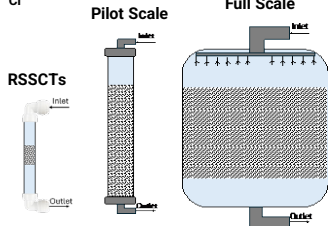
$$\frac{EBCT_{SC}}{EBCT_{LC}} = \left(\frac{d_{p,SC}}{d_{p,LC}}\right)^{2-X}$$

dp (cm): Particle diameter. SC and LC: Small column (RSSCT) and large column (pilot column), respectively. X: dependence of the intraparticle diffusion coefficient on particle size: X= 0 for constant diffusivity and X=1 for proportional diffusivity.



Grinding Techniques

*Blender Grinding (BG)
*Freeze Dry & Blender Grinding (FD&BG)
*Mortar & Pestle (MP)
*Ball Milling (BM)
*Jet Milling (JM)



Results

The Impact of Grinding Techniques on the Adsorption of PFAS

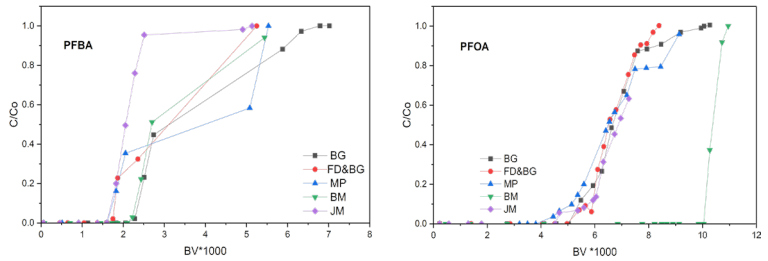


Fig 2. Comparison of RSSCT breakthrough profiles for PFBA and PFOA using different grinding techniques

Results

The Influence of Grinding Techniques on the Prediction Accuracy

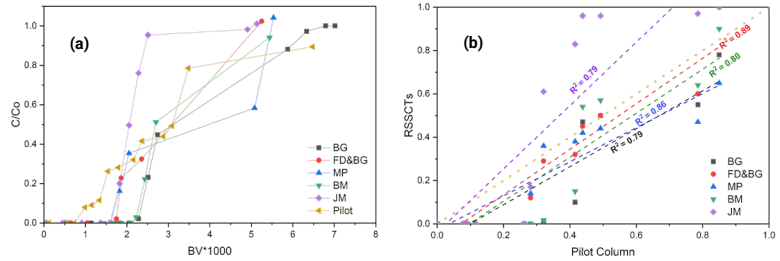


Fig 3. Comparison of PFBA (**a**) breakthrough profiles and (**b**) correlations between RSSCTs versus pilot column results for different grinding techniques

Key Findings

- Resin grinding methods have significantly influenced PFBA and PFOA breakthrough profiles.
- PFBA breakthrough profiles were followed the order of ~4,000 BV_{50} (MP) > 3,100 BV_{50} (BG and FD&BG) > 2,700 BV_{50} (BM) > 2,000 BV_{50} (JM), while PFOA breakthrough profiles were in the order of ~10,300 BV_{50} (BM) > 6,900 BV_{50} (JM) > 6,600 BV_{50} (BG) > 6,500 BV_{50} (MP and FD&BG).
- PFBA adsorption efficiency in RSSCTs for predicting Pilot Scale performance is ranked in the following order: FD&BG (89.1%) > MP (86.1%) > BM (80.2%) > JM (79.2%) > BG (78.9%).

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References

Ersan Research Lab

For More Information

WQRF | Water Quality Research Foundation

PENTAIR WATER SOLUTIONS