Novel β-cyclodextrin Polymer Adsorbents for Removal of PFAS from Diverse Water Matrices

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PFAS – Forever Chemicals in Water

- PFAS: Per- and polyfluorinated alkyl substances
- Widely-used: firefighting and household products
- Pervasive – GW, SW, WW, Leachate
- Persistent, Bio-accumulative, and Toxic

- Over 6,000 different PFAS structures

Challenges: PFAS are difficult to remove:
1. diverse chemical structures;
2. low concentrations (ng/L to μg/L);
3. present in complex water matrices.

Point source and Nonpoint source Contamination:
PFAS’s surfactant nature and high stability = Persistence
PFAS – Treatment Technology

Activated Carbon

Ion Exchange Resin

Cyclodextrin Polymers

Reverse Osmosis

Shellfish Allergy

The water in both tanks is from the same time and place. The only difference is that the right tank has oysters.

DEXSORB®

1. From corn...
2. to kernel...
3. to corn starch...
4. to beta cyclodextrin
5. one-step polymerization
6. to DEXSORB!
7. PFAS-free drinking water
8. DEXSORB®’s .78nm cups bind PFAS
Proprietary Technology: DEXSORB®

One-Step Synthesis: 1 gram of DEXSORB = $3 \times 10^{20}$ cyclodextrin cups

Features:
1. High Selectivity for micropollutants like PFAS.
2. Rapid Kinetics in both powder and granular forms.
3. High Capacity for micropollutant uptake.
4. Resistance to fouling of TOC and TDS (size exclusion).
5. Easy regeneration for multi-cycle reuse.

PFAS:
i.e. GenX, PFOA, PFOS
Unique Feature: Size Exclusion & Size Inclusion

Host-Guest Complexation

- Size inclusion for PFAS

- Size exclusion for NOM, inorganic ions, etc.
Performance: Consistent PFAS Removal in Complex Matrices

Resistant to Matrix Effects:
- Consistent performance across different water quality conditions (e.g., DOM)
- Allows application in diverse water matrices

Efficiency at High PFAS Contamination:
- Rapid and efficient removal across different PFAS chain lengths and contamination levels
Drinking water PBF treatment at Town X, MA

RSSCT Conditions:

- Run for 10 days
- Simulated EBCT: 5 min
- Throughput: 5 gallons
- Loading: 0.08 g.

Performance:

- 1 kg for the treatment of more than 150,000 L;
- Equally effective against short- & long-chain PFAS

Massachusetts Regulated PFAS Breakthrough

- PFOA+PFOS+PFNA+PFHxS+PFHpA
- Total Influent Concentration

Specific Throughput (L/kg)

Fraction collector

Waste tank

Stock tank

Inlet

HPLC pump

Cyclopure
RSSCT results, superior PFAS removal:

PFOS Breakthrough
- PFOS
- Influent Concentration

PFOS +PFOA Breakthrough
- PFOA+PFOS
- Influent Concentration

On-site pilot test, CP compact vessel system:
Third-party leachate treatment study:

- DEXSORB+ Dose: 5 g/L; Contact time: 30 minutes
- TOC: > 1000 mg/L; TDS: > 5000 mg/L

Important Observations:

- Rapid kinetics and high capacity are maintained in the most challenging matrix
- Both short- and long-chain can be effectively removed
DEXSORB®: From Separation to Mineralization for PFAS

DEXSORB+ Treatment Train:
1) PFAS Remediation
2) Adsorbent Regeneration
3) PFAS Destruction
4) Adsorbent Reuse

Multi-cycle regeneration for Reuse

EPA funded Proprietary Process
DEXSORB®: Effective Uptake of Emerging PFAS


DEXSORB® exhibits efficient removal of zwitterionic, anionic, and non-ionic PFAS.

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DEXSORB® show broad efficacy against all 68 identified PFAS in short contact time.
Thanks for your attention!

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