Carbon-cryogel hierarchical composites as effective and scalable filters for removal of trace organic pollutants from water

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Abstract

Effective technologies are required to remove organic micropollutants from large fluid volumes to overcome present and future challenges in water and effluent treatment. A novel hierarchical composite filter material for rapid and effective removal of polar organic contaminants from water was developed. The composite is fabricated from phenolic resin-derived carbon microbeads with controllable porous structure and specific surface area embedded in a monolithic, flow permeable, poly(vinyl alcohol) cryogel. The bead-embedded monolithic composite filter retains the bulk of the high adsorptive capacity of the carbon microbeads while improving pore diffusion rates of organic pollutants. Water spiked with organic contaminants, both at environmentally relevant concentrations and at high levels of contamination, was used to determine the purification limits of the filter. Flow through tests using water spiked with the pesticides atrazine (32 mg/L) and malathion (16 mg/L) indicated maximum adsorptive capacities of 641 and 591 mg pollutant/g carbon, respectively. Over 400 bed volumes of water contaminated with 32 mg atrazine/L, and over 27,400 bed volumes of water contaminated with 2 μg atrazine/L, were treated before pesticide guideline values of 0.1 μg/L were exceeded. High adsorptive capacity was maintained when using water with high total organic carbon (TOC) levels and high salinity. The toxicity of water filtrates was tested in vitro with human epithelial cells with no evidence of cytotoxicity after initial washing.

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