

Title: Nickel-iron Prussian blue composite membranes with ion-sieving channels for targeted cesium ion capture in aquatic systems

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Abstract: This study successfully fabricated Ni-Fe Prussian blue analogues (PBAs) on polytetrafluoroethylene (PTFE) membranes (Ni-Fe PBAs@M) through interfacial functionalization and *in situ* crystal growth. Structural and compositional analyses confirmed the formation of a hierarchical porous structure with uniformly distributed PBA nanocubes (55–80 nm), cyanide-bridged coordination, and a 2.1-fold increase in surface area. Under optimized synthesis conditions (Ni/Fe molar ratio 3:2, 60 °C, Ni(NO₃)₂ precursor), the membranes achieved over 99 % Cs⁺ removal from 0.05 ppm solutions within 60 min, with a considerable and promising adsorption capacity of 444.00 mg·m⁻² at 5.0 ppm Cs⁺. Performance remained stable across transmembrane pressures (0.1 MPa) and pH levels (5–10), with slightly enhanced kinetics under acidic conditions. The membrane exhibited strong selectivity, retaining over 92 % Cs⁺ removal efficiency even in the presence of high concentrations of competing ions (Na⁺, K⁺, Ca²⁺, Mg²⁺, 10²-fold excess), which is attributed to the favorable hydration radius of Cs⁺. Water-based regeneration maintained >97.5 % removal efficiency over three cycles. In real-world applications, the membrane achieved >90 % Cs⁺ removal from Pearl River water and ~50 % removal from salt-lake brine, despite extreme ionic competition exceeding Cs⁺ concentrations by >10⁴-fold. Mechanistic investigations revealed that Cs⁺

Keywords: Ni-Fe Prussian blue analogues Cs⁺ removal Functional membrane Selective adsorption Coordination mechanism

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