[Oral presentation]

Development of a 3D-printed PLA scaffold coated with cobalt hexacyanoferrate for selective NH_4^+ recovery

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ABSTRACT

Ammonium (NH_4^+) in aquatic environments is recognized as a major contributor to eutrophication and air pollution, while concurrently constituting a valuable recoverable resource as a hydrogen carrier. This dual role underscores the importance of technologies capable of both NH_4^+ removal and resource recovery. Prussian Blue Analogues (PBAs), known for their selective cation exchange capability, are promising NH_4^+ adsorbents. Previous studies showed that powdered Cobalt Prussian Blue (CoPBA) has excellent performance; however, powder adsorbents exhibit limitations in process application due to recovery difficulty and contamination risk. Therefore, to overcome these limitations, this study aimed to develop a novel adsorbent by utilizing additive manufacturing to create a structurally uniform 3D-printed PLA support and coating CoPBA onto its surface (CoPBA@PLA).

To achieve successful coating on the PLA surface, a surface modification process was conducted to impart physical roughness and crucial functional groups (-COOH, -OH). The CoPBA@PLA composite was then synthesized using a layer-by-layer method. Successful formation and integrity were evaluated by characteristic analysis (SEM-EDS, FT-IR, XRD). Furthermore, continuous column experiments were performed to simulate actual process conditions and quantitatively analyze adsorption-desorption behavior and concentration properties. Subsequently, the structural and chemical stability of the CoPBA@PLA was comprehensively evaluated after long-term column operation.

In conclusion, CoPBA@PLA demonstrated a maximum adsorption capacity of 4.95 mg/g and maintained high selectivity toward NH_4^+ against competing cations (Na^+, K^+). Its uniform 3D structure is expected to enable stable operation in continuous processes. Crucially, the CoPBA@PLA maintained stable adsorption performance over five regeneration cycles. When applied to a column system, the adsorbents achieved an ammonium concentration factor (CF) of 2.66 during long-term operation. These findings indicate CoPBA@PLA possesses both structural stability and high reusability, supporting its potential as a sustainable solution for ammonium recovery.

Keywords: Ammonium recovery, 3D-printing, Prussian blue analogue, Selective adsorption

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