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Optimizing COFs Properties for Uranium Uptake: The Role of Alcohol in Aqueous Precipitation

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The use of Covalent Organic Frameworks (COFs) in uranium adsorption has gained attention due to their potential in nuclear waste remediation. Traditional solvothermal synthesis methods, while effective, require high temperatures, long reaction times, and toxic solvents, limiting their scalability. This study introduces an alternative Dissolution-Precipitation (DP) synthesis method for COF formation, exploring the impact of different alcohol precipitants (ethanol, isopropanol, and butanol) on COF morphology, stability, and uranium adsorption performance. The novelty of this work lies in evaluating the role of alcohol choice in tailoring COF properties, addressing a research gap in solvent engineering for COF development.

COFs were synthesized using both DP and solvothermal methods, with yields of 87% (COF-EtOH), 93% (COF-IPA), and 47% (COF-BuOH) for the DP method, and 98% for solvothermal COFs. Structural and morphological analyses were performed using NMR, FTIR, SEM, BET, and XRD. Uranium adsorption was assessed under varying conditions, with COF-IPA showing the highest adsorption capacity of 800 mg/g, achieving 80% uranium uptake. Langmuir modeling ($R^2 > 0.99$) confirmed monolayer chemisorption, with COF-IPA outperforming COF-EtOH (625 mg/g) and COF-BuOH (714 mg/g) due to its optimal porosity, sulfonate density, and colloidal stability.

The findings highlight that alcohol selection significantly influences COF performance, with COF-IPA showing the most promise for uranium recovery. This study demonstrates that DP synthesis, with careful solvent choice, provides an environmentally friendly and scalable route for COF-based uranium capture, positioning it as a viable alternative to traditional methods in nuclear waste remediation.

Technical Track

Fuel Cycle and Waste Management

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