Divide et Empera: Key Separations to Unlock Carbon-Efficient Utilisation of Lignocellulose in Advanced Biorefineries

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Addressing the urgent global demand for sustainable and carbon-efficient technologies in the biomass conversion sector necessitates the strategic implementation of advanced processes for lignocellulose deconstruction within biorefineries. This optimisation of lignocellulosic biomass utilisation is crucial for achieving sustainability goals. In this talk, we will present concepts that leverage cutting-edge techniques such as catalytic fractionation methods and advanced adsorption technologies to enhance both the selectivity and efficiency of biomass deconstruction and conversion processes. Our research focuses on developing highly selective adsorbents for the sequestration of aromatic compounds, essential for purifying crude hydrolysates obtained from the acid hydrolysis of lignocellulose. In the context of sugar utilisation, these adsorbents effectively remove inhibitory compounds without the loss of fermentable sugars, enabling ethanol production from hydrolysates at efficiencies comparable to those achieved with high-purity-grade glucose. Moreover, these adsorbents also facilitate the downstream separation of lignin streams obtained from the reductive catalytic fractionation of lignocellulosic materials. For lignin valorisation, these adsorbents selectively extract the heavy fractions of lignin species in biorefinery streams, allowing for their utilisation in value-added applications. This talk will propose a paradigm shift in biorefinery operations, encouraging for a more segmented and strategic approach to biomass processing that aligns with the principles of green chemistry and industrial sustainability. By integrating these advanced separation technologies into current practices, we can significantly improve the carbon efficiency and overall sustainability of biorefineries, contributing to reducing greenhouse gas emissions and promoting a circular economy.