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Photocatalytic Depolymerization of Sodium Lignosulfonate in Seawater Using Anthraquinone-2-Sulfonate as a Photocatalyst

The valorization of biomass-based waste products such as lignin or lignosulfonates to produce value-added compounds through depolymerization is of great importance in tackling the problems arising from the world' s dependence on fossil-based resources. Especially interesting are lignosulfonates because of their water solubility and the possibility of promoting reactions without the need for harsh conditions such as high base loadings. In this project, the commercially available, non-toxic, and water-soluble anthraquinone-2-sulfonate is employed as a photocatalyst to depolymerize sodium lignosulfonate under mild conditions. The reaction is carried out in aqueous sodium chloride solution, which stabilizes the catalyst, and can proceed at room temperature and under ambient air, using UV LED irradiation as the driving force. The solubility of both catalyst and substrate in water eliminates the need for strong bases, other solubilizing agents, or organic solvents. The progress of depolymerization is monitored using various analytical techniques, which clearly reveal the breaking down of native sodium lignosulfonate. UV-vis measurements at different times reveal a significant decrease in the concentration of aromatic groups accompanied by a color change in the solution from deep brown to transparent and colorless. While NMR and IR spectroscopy indicate that structural changes occur over time, the key structural motifs are retained, suggesting that the resulting lower molecular weight compounds preserve some of the original functionalities. Notably, the reaction proceeds even in untreated and unfiltered seawater obtained directly from the Baltic Sea, without the need to resort to model compounds or idealized reaction conditions. The ability to conduct the reaction in seawater could eliminate the need for purified solvents, simplifying the process and lowering overall costs. This approach highlights a promising direction for biomass valorization, offering both a sustainable and efficient alternative.

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