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Assembly of sodium lignosulfonate-metal hybrids as highly efficient adsorbents for rapid removal of dye molecules

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ABSTRACT

This present work describes a pH-driven approach for synthesizing sodium lignosulfonate-metal ions (SL-M) hybrids as highly efficient adsorbent for the rapid removal of dye molecules, including cationic dye (such as Methylene blue, MB), anionic dye (such as Coomassie Brilliant Blue R-250, CBB R-250) and non-ionic dye (such as Rhodamine B, RB). The structural properties of as-synthesized hybrids are characterized using scanning electron microscopy, energy-dispersive X-ray spectroscopy-mapping, Fourier-transform infrared spectroscopy and Brunauer–Emmett–Teller techniques. The adsorption experiments yielded a maximum adsorption capacity of 10,416.51 mg/g of CBB R-250 over SL-Cr^{3+}, 926.97 mg/g of MB over SL-Mn^{2+}, and 880.98 mg/g of RB over SL-Fe^{3+} hybrid at 25°C. The adsorption behavior of SL-M hybrids follows Langmuir isotherm and pseudo-second-order kinetic models well. Thermodynamic studies point out that dye adsorption is spontaneous and endothermic. The dyes adsorption mechanism of SL-M hybrids is probably ascribed to electrostatic interactions, hydrogen bonding, van der Waals forces and π–π stacking interaction. The practical application of SL-M hybrids was demonstrated through the preparation of an SL-M membrane for efficient removal of mixed dyes. Furthermore, the effect of pH and salinity on the dye removal by the SL-M membrane was also investigated. Overall, these findings demonstrate that SL-M hybrids have the potential to serve as an excellent adsorbent for the rapid removal of dyes from polluted water in the future.

Keywords: Sodium lignosulfonate-metal (SL-M) hybrids; Dyes adsorption; Kinetics; Isotherm; Thermodynamics

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