Adsorption of methylene blue on chemically modified pine nut shells in single and binary systems: isotherms, kinetics, and thermodynamic studies

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ABSTRACT

In the present work, modified sodium hydroxide-treated pine nut shells (PNSM) were used for the selective removal of methylene blue (MB) from the single and binary (with amaranth dye) systems by batch method. The material was characterized and identified by different techniques such as X-ray diffraction, Brunauer, Emmett and Teller, Fourier transform infrared and scanning electron microscopy (SEM). The distinctive properties such as low pore volume (0.060 cc/g), high surface area (>266 m\textsuperscript{2}/g), and existence of a variety of functional groups made it feasible for the removal of MB efficiently. Maximum MB adsorption (39.73 mg/g) was observed at pH 5.9. In the binary component system, the amaranth dye played a significant role to enhance the MB adsorption. Kinetic modeling studies showed the applicability of a pseudo-second-order model for the selective adsorption of MB in single and binary systems. Thermodynamic factors suggested that the adsorption was chemical, spontaneous, and endothermic in nature. Desorption studies showed optimum MB recovery (92.54%) with 0.1 M oxalic acid solution. The outcomes revealed that the used agricultural waste was a probable cost-effective adsorbent for the selective removal of MB from aqueous medium.

Keywords: Pine nut shells; Selective adsorption; Methylene blue; Amaranth; Desorption

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