Kinetics and thermodynamics of cationic dye adsorption onto dry and swollen hydrogels poly(acrylic acid-sodium acrylate-acrylamide) sodium humate

Tripti Singh, Reena Singhal*

Department of Plastic Technology, Harcourt Butler Technological Institute, Kanpur 208002, India
Emails: reena_singhal123@rediffmail.com; reenasinghal123@gmail.com

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ABSTRACT

A novel superabsorbent hydrogel (SAH) composed of poly(acrylic acid-sodium acrylate-acrylamide)/sodium humate poly(AAc-SA-AM)/SH was synthesized and applied as adsorbent to adsorb crystal violet (CV) and methylene blue (MB) dye in its dry as well as swollen condition from the aqueous solutions. The swelling ratios of the synthesized SAHs were determined. The factors affecting adsorption capacity of the poly(AAc-SA-AM)/SH hydrogel, such as contact time, temperature, SH content (wt.%), and initial concentration of both dyes, were systematically investigated. The experimental data suggested that an appropriate addition of SH (2.40 wt.%) increases the swelling ratio as well as adsorption capacity of poly(AAc-SA-AM) hydrogel. The adsorption capacity was approximately equal for the dry (231 mg/g for CV and 270 mg/g for MB) and equilibrium SAHs (240 mg/g for CV and 278 mg/g for MB). The results also revealed that the swollen SAHs exhibited higher adsorption rate than the dry SAHs due to presence of functional anionic groups in its elongated state. The adsorption equilibrium data fitted very well to the Langmuir isotherm than the Freundlich isotherm. Thermodynamic parameters of adsorption were also calculated, and the negative change in $\Delta G^\circ$ and $\Delta H^\circ$ confirmed that the dye adsorption process was spontaneous and exothermic in nature. The kinetic studies showed that the adsorption phenomenon followed the pseudo-second-order kinetic model.

Keywords: Hydrogels; Dye adsorption; Adsorption kinetics; Thermodynamic parameter

*Corresponding author.

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