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An adsorption and kinetic study of lac dyeing on silk

Montra Chairat[a], Saowanee Rattanaphani[a,*], John B Bremner[b],
Vichitr Rattanaphani[a]

[a]*School of Chemistry, Suranaree University of Technology, Nakhon Ratchasima, Thailand, 30000*
[b]*Institute for Biomolecular Science and Department of Chemistry, University of Wollongong, NSW, 2522, Australia*

Abstract

Adsorption and kinetic studies of lac dyeing of silk were investigated using, as optimal conditions, a pH of 3.0, a material to liquor ratio (MLR) of 1:100, an initial dye concentration of 450 mg/L and 60 min contact time. The progress of dye adsorption was monitored at λ_{max} 487 nm by visible spectroscopy. The experimental data fitted well to the Langmuir and Freundlich isotherms with a high correlation coefficient (R^2). The pseudo second-order kinetic model was indicated with the activation energy of 47.5 kJ/mol. It is suggested that the overall rate of lac dye adsorption is likely to be controlled by the chemical process. The values of the enthalpy ($\Delta H^{\#}$) and entropy of activation ($\Delta S^{\#}$) were 44.7 kJ/mol and −175.7 J/mol K, respectively. The free energy of activation ($\Delta G^{\#}$) at 30 °C was 97.9 kJ/mol. The activation parameters with and without erythrolaccin in the lac dye were similar, consistent with erythrolaccin only having a slight effect on the lac dyeing of silk. The free energy (ΔG°), enthalpy (ΔH°) and entropy (ΔS°) terms for the lac dyeing were also determined, and the negative values of ΔG° and ΔH° obtained indicated that the lac dye adsorption process is a spontaneous and an exothermic one.