

Enhancement of phenol adsorption on mesoporous carbon monolith modified by NaOH and NH₃: equilibrium and kinetic studies

ABSTRACT

Carbon-coated monoliths (CCMs) were chemically modified by sodium hydroxide (NaOH) and ammonia aqueous solution (NH₃) in order to enhance phenol adsorption. The adsorptive performance of phenol onto CCM-NaOH and CCM-NH₃ was comparatively evaluated by batch mode. Experiments were carried out by varying pH, contact time, and initial adsorbate concentration. The optimum molarities for modification were 1.5 M NaOH and 2 M NH₃ solutions. The basicity groups of modified CCM were 0.198 and 0.339 mmol g⁻¹ for CCM-NaOH and CCM-NH₃ by Boehm titration method, respectively. The presence of basic groups (OH and NH₃) was also confirmed by FT-IR. The studies showed optimum phenol adsorption, at pH 4 for both adsorbents. As compared to unmodified CCM, the CCM-NH₃ and CCM-NaOH enhanced phenol uptake by 16.5 and 9.7%, respectively. The maximum equilibrium adsorption capacities were 51.29 ± 0.7 mg g⁻¹ for CCM-NaOH and 54.45 ± 0.7 mg g⁻¹ for CCM-NH₃ in the range of concentration 50-350 mg L⁻¹. The equilibrium adsorption data for CCM-NaOH and CCM-NH₃ was fitted to both Langmuir and Freundlich models. Kinetic studies of both modified CCMs showed better applicability of pseudo-second-order kinetics model. The regeneration studies showed a 26% drop in adsorption capacity after four cycles for CCM-NH₃.

Keyword: Ammonia; Mesoporous carbon-coated monoliths; Phenol adsorption; Sodium hydroxide; Surface modification