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Optimization of ammonium adsorption from landfill leachate using montmorillonite/hematite nanocomposite: response surface method based on central composite design

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ABSTRACT

In this study, the adsorption of ammonium ions from landfill leachate (LL) was examined using montmorillonite/hematite nanocomposite (M/HNC). Parameters affecting ammonium adsorption such as pH 3–11, adsorbent dosage 0.05–0.25 g/L, mixing speed 75–175 rpm, and contact time 25–125 min were assessed. The central composite design (CCD)–based response surface methodology was employed to design the experiments and find optimal conditions. M/HNC was synthesized under green conditions and structurally investigated using X-ray powder diffraction, Fourier-transform infrared spectroscopy, Brunauer–Emmett–Teller, and scanning electron microscopy techniques. M/HNC was synthesized with a particle size of about 26 nm, magnetic properties, and a high specific surface area. The efficiency of ammonium adsorption from LL was increased by enhancing parameters such as pH, adsorbent dosage, mixing speed, and contact time. The pH of 8.05, adsorbent dosage of 0.167 g/L, mixing speed of 117.42 rpm, and contact time of 81.99 min was presented as optimal conditions according to the results of the CCD method. In addition, the efficiency of ammonium adsorption from LL using M/HNC was 80% at optimal conditions. The data of ammonium adsorption on M/HNC fitted well with pseudo-second-order kinetic and Langmuir isotherm models. It should be noted that the interactive effects of the parameters had an increasing impact on the ammonium adsorption efficiency. Based on the results of the present study, M/HNC had an effective potential for the adsorption of ammonium from LL.

Keywords: Ammonium; Landfill leachate; Montmorillonite/hematite nanocomposite; Central composite design

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