KINETICS AND ADSORPTION ISOTHERMS OF Pb (II) IN SOILS USING ZERO-VALENT IRON NANOPARTICLES FUNCTIONALIZED WITH QUINOA RESIDUAL BIOMASS

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ABSTRACT

Lead (Pb(II)) contamination in soils is a major environmental concern because of its toxicity, persistence, and adverse effects on ecosystems and human health. This study evaluated the use of zero-valent iron nanoparticles functionalized with quinoa residual biomass as an efficient adsorbent for Pb(II) removal from contaminated soils. The synthesized nanoparticles were characterized by Fourier Transform Infrared Spectroscopy (FTIR), which confirmed the presence of carboxyl, hydroxyl, and amino functional groups involved in the adsorption process.

Batch adsorption experiments were carried out to evaluate the adsorption kinetics and equilibrium behavior. The kinetic data showed the best fit with the pseudo-second-order model, presenting a correlation coefficient of R^2 = 0.9901, indicating that chemisorption is the dominant mechanism controlling Pb(II) uptake. Equilibrium studies demonstrated that the Langmuir isotherm model best represented the experimental data, with R^2 = 0.9946, suggesting homogeneous monolayer adsorption on the adsorbent surface.

The separation factor RL was 0.1142, confirming a favorable adsorption process (0 < RL < 1). In addition, the maximum adsorption capacity (Qmax) reached 322.58 mg/g, while the Langmuir constant KL was 1.347, demonstrating high affinity between Pb(II) ions and the adsorbent material. These results highlight the potential application of this sustainable nanomaterial for soil remediation.

Keywords: adsorption, isotherms, kinetics, Pb(II), zero-valent iron nanoparticles, quinoa residual biomass, soil remediation.

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