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The Adsorption of Pb2+ and Cu2+ onto Gum Ghatti-Grafted Poly(acrylamide-co-acrylonitrile) Biodegradable Hydrogel: Isotherms and Kinetic Models

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Abstract

A biodegradable hydrogel polymer of gum ghatti (Gg) with a copolymer mixture of acrylamide (AAm) and acrylonitrile (AN) was synthesized using the free-radical graft copolymerization technique. The effect of graft copolymerization on the surface area of Gg was studied using BET analyses. The graft copolymerization of Gg with poly(AAm-co-AN) was characterized using Fourier transform infrared spectroscopy, CHN analysis, thermogravimetric analysis, atomic force microscopy, and scanning electron microscopy. The adsorption of Pb(sup2+) and Cu(sup2+) from aqueous solution using the Gg-cl-P(AAm-co-AN) hydrogel polymer was studied in batch mode. The adsorption process was found to be highly pH dependent, and the maximum adsorption efficiency was observed at pH 5.0 for both metal ions. The adsorption isotherm data were analyzed by applying five different isotherm models, namely, the Langmuir, Freundlich, Temkin, Flory-Huggins, and Dubinin-Kaganer-Radushkevich isothermal models. The Langmuir model was found to fit well with the experimental isotherm data, with a maximum adsorption capacity of 384.6 and 203.7 mg/g for Pb(sup2+) and Cu(sup2+), respectively. The metal ion-adsorption process was found to be controlled by the pseudo-second-order rate model. The Gg-cl-P(AAm-co-AN) hydrogel polymer retained its original adsorption capacity for three successive cycles of adsorption-desorption. In summary, the potential for remediating industrial wastewater polluted by metal ions using the biodegradable Gg-cl-P(AAm-co-AN) hydrogel polymer has been demonstrated.