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Valorization of chitosan-Argan nutshell biocomposite beads by application in adsorption of heavy metals radioactive waste: using response surface methodology

The Radioactive waste is generated from various sectors such as medical institutions and industrial processes involving radioactive materials. This waste must be managed adequately to ensure safely and securely to protect human and his environment without making any constraints on the future generations. Many methods have been developed to address this problem, the most widely used technique being adsorption. Green adsorption has recently been developed to valorize biomaterials. Research on chitosan (CS), a natural biopolymer found in crustacean and insect shells, and in the cell walls of fungi, has been considered a golden age. It is thus the second most abundant biopolymer after cellulose on the planet. The biocompatibility, biodegradability, non-toxicity and versatility of CS favor its use in several processes. In this context, the Argan nutshell (ANS) is also considered as a biomaterial to be valorized. The ANS is the residue of the extraction of the fruit of the Argan tree which is found in southwestern Morocco. This biomaterial is a solid agricultural waste and lignocellulosic materials. Hence, the aim of this work is to valorize two abundant wastes and develop a biocomposite made from natural resources to look for specific properties such as environmental friendliness and low cost. Secondly, the preparation and characterization of the biocomposite beads of CS/ANS for heavy metals sorption from aqueous solution in continuous and discontinuous systems. The bio-composite beads were characterized by XRD, BET, FTIR, SEM, TGA, and PZC. Then, the impact of several parameters, such as heavy metal initial concentration, adsorbent dosage, pH, and contact time, were studied and investigated using isotherms, kinetics, and thermodynamic models. Furthermore, response surface methodology (RSM) was established to optimize the discontinuous system. In order to evaluate the continuous behavior, various parameters such as rate flow, inlet concentration, and column bed height were investigated to describe the performance of the adsorbent column using the breakthrough curve. Yoon-Nelson, Thomas, and Adams–Bohart diffusion models were fitted to experimental breakthrough data.

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