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Fe_2O_3 Nanoparticle Loaded Gracilaria verrucosa Biomass Performance for Removal of Cu(II) and Cd(II) Ions from Single and Binary Solutions

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Human activities introduce heavy metals to the hydrosphere in many ways such as burning of fossil fuels, smelting of ores, municipal sewage, industrial effluent, mining activities, landfill, mineral weathering, underground toxic waste disposal, etc.. These contaminants, regardless of their sources, are easily dispersed into the aquatic system, and tend to accumulate in living organisms, resulting in various disorders and diseases in the ecosystem. Over the last decades, biosorption has gained importance in the field of water and wastewater treatment. Many studies have demonstrated that biosorption, a part of being a low cost technique, is simple, environmentally friendly and shows a good performance for the separation and removal of organic and inorganic pollutants. Since, it is unusual to find stream of wastewater contaminated by only a sole pollutant, the intensity of interaction which depends on concentration of each component of a multi-component system should be considered.

Besides experimental conditions, sorbent material characteristics is another key point to determine the intensity. Sorbents with higher specific surface area possess superior sorption capacity with better mass transfer efficiency. However, a high pressure drop may be encountered with the compact sorbent in a packed bed adsorption column if the particle diameter is smaller. Also, the separation technology of ultrafine particles, especially nano-scale particles, is still under development and presents difficulties to a certain extent. To come over these difficulties on application, nano sized materials can be loaded on different supports. With the knowledge of algal biomass efficiency on removal by loading nanomaterials onto biomass, enhanced sorption capacities can be achieved.

In this study; the sorption capacity of *Gracilaria verrucosa* for Cu(II) and Cd(II) ions from single and binary solutions was investigated. For this aim raw, acid modified and Fe_3O_4 nanoparticles which were produced by low pressure flame synthesis method loaded on acid modified biomass was used as a sorbent. Batch metal sorption experiments to obtain the equilibrium data were performed under controlled temperature, constant shaking and pH. The sorption capacity of raw, acid modified and nano-loaded biomass for single contamination condition was found as for Cu(II) 136.3, 158.80, 285.42 and for Cd(II) 118.34, 132.36 and 172.35 mg/g simultaneously. The sorption capacity of sorbents was decreased approximately 78% on the case of multi-component pollution for Cu(II) removal.

To fit the mono-component equilibrium data six sorption isotherms have been tested and the best description obtained by the Sips equation. A modified extended-to-multi-component Langmuir-type isotherm model was applied to predict the binary sorption data and its adjustable parameters were estimated with MATLAB Surface Fitting Tool. Finally, the results have shown that the affinity of each metal ion onto sorbent surface is influenced by the presence of the other one, with an antagonistic behavior.

Keywords: Fe_2O_3 nanoparticles, multi-component biosorption, heavy metal, modelling