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Treatment of a Galvanization Wastewater in a Fixed-Bed Column Using L. hyperborean and P. canaliculata Macroalgae as Natural Cation Exchangers

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Abstract : Two brown macroalgae, Laminaria hyperborea and Pelvetia canaliculata, were employed as natural cation exchangers in a fixed-bed column for Zn(II) removal from a galvanization wastewater. The column (4.8 cm internal diameter) was packed with 30-59 g of previously hydrated algae up to a bed height of 17-27 cm. The wastewater or eluent was percolated using a peristaltic pump at a flow rate of 10 mL/min. The effluent used in each experiment presented similar characteristics: pH of 6.7, 55 mg/L of chemical oxygen demand and about 300, 44, 186 and 244 mg/L of sodium, calcium, chloride and sulphate ions, respectively. The main difference was nitrate concentration: 20 mg/L for the effluent used with L. hyperborean and 341 mg/L for the effluent used with P. canaliculata. The inlet zinc concentration also differed slightly: 11.2 mg/L for L. hyperborean and 8.9 mg/L for P. canaliculata experiments. The breakthrough time was approximately 22.5 hours for both macroalgae, corresponding to a service capacity of 43 bed volumes. This indicates that 30 g of biomass is able to treat 13.5 L of the galvanization wastewater. The uptake capacities at the saturation point were similar to that obtained in batch studies (unpublished data) for both algae. After column exhaustion, desorption with 0.1 M HNO3 was performed. Desorption using 9 and 8 bed volumes of eluent achieved an efficiency of 100 and 91%, respectively for L. hyperborean and P. canaliculata. After elution with nitric acid, the column was regenerated using different strategies: i) convert all the binding sites in the sodium form, by passing a solution of 0.5 M NaCl, until achieve a final pH of 6.0; ii) passing only tap water in order to increase the solution pH inside the column until pH 3.0, and in this case the second sorption cycle was performed using protonated algae. In the first approach, in order to remove the excess of salt inside the column, distilled water was passed through the column, leading to the algae structure destruction and the column collapsed. Using the second approach, the algae remained intact during three consecutive sorption/desorption cycles without loss of performance.

Keywords : biosorption, zinc, galvanization wastewater, packed-bed column
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