REMOVAL OF COPPER IONS FROM AQUEOUS SOLUTIONS BY SUGAR BEET SHREDS AND POPLAR SAWDUST IN A FIXED-BED COLUMN

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Abstract

The potential use of sugar beet shreds and poplar sawdust for copper ions removal from aqueous solution in a fixed-bed column was investigated. Experiments were performed in a glass column (inner diameter 2.204 cm and length 50 cm), in the down-flow mode with a flow rate set to approximately 12 mL/min. Concentration (C_0) and the pH of the inlet solution were 100 mg/L and 4.5, respectively, and 10 g of the adsorbent were used to form a bed of nearly 19 cm in length. Sugar beet shreds and poplar sawdust were milled and sieved through the set of sieves, and the fraction of 400 to 600 μm was used for the adsorption experiments. The consecutive aliquots of 50 to 150 mL were collected at the bottom of the column, and they were analyzed for the content of the Cu(II) ions (C), according to the standard method of complexometric titration [1]. The column adsorption process is described regarding the effluent concentration-volume profile, or the breakthrough curve, obtained from the plot of C_t/C_0 versus volume of the effluent. The shape of the curve gives an insight into the dynamic behavior of the process [2, 3]. Various mathematical models can be used to describe fixed-bed adsorption [4, 5]. In this research, the novel two-stage approach for the breakthrough curve modelling was applied. The fit quality, expressed as coefficient of determination (R^2) and the sum of squared errors (SSer), showed that this model fits the experimental data more accurately than any other commonly used one-stage model. Namely, R^2 and SSer for sugar beet shreds were 0.9984 and $9.69 \cdot 10^{-3}$, respectively, while for the poplar sawdust they were 0.9999 and $2.87 \cdot 10^{-4}$, respectively. The characteristic value that describes this two-stage phenomenon is moiety of each stage, p. In the case of sugar beet shreds it was 0.43, while for the poplar sawdust it was 0.85. These results suggest that the adsorption of the copper ions onto examined biosorbents occurs under multiple mechanisms, occurring simultaneously but shifting in the dominance. When using sugar beet shreds as an adsorbent, these mechanisms are nearly equal in their dominance (0.43 to 0.57). In the case of the poplar sawdust one mechanism is significantly more dominant then other (0.85 to 0.15), and the misuse of one-stage models is usual and more likely. However, the extensive mathematical and statistical analysis confirmed the validity of the two-stage modelling approach for the copper biosorption onto sugar beet shreds and poplar sawdust.

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