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APPLICABILITY OF DIFFERENT KINETIC MODELS ON BIOSORPTION OF MOLASSIGENIC METAL IONS IN CLOSED-LOOP FIXED-BED COLUMN SYSTEM

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Valorization of by-products from the food industry is a generally accepted trend with an increasing tendency of its application in everyday life. One of the most difficult sustainability challenges is to overcome problems with an enormous amount of accumulated sugar beet pulp. Annually, around 15 million tons of sugar beet has been processed only in the EU. Novel findings have been directed towards the reutilization of the sugar beet pulp as an effective cation-exchange biomaterial. Sugar beet pulp was used as a biosorbent for molassigenic metal ions removal from the alkalized juice. Alkalized juice represents an intermediate product of the sugar juice processing stage. Dry matter (DM) of the alkalized juice represents only sucrose and macroelements (minerals). Sodium (Na) and potassium (K) are present in an alkalized juice in the amount of 9500 mg/ kg DM, whereas calcium (Ca) is present in the lower amount (700 mg/kg DM). Since all of the processes in the sugar industry are continual, biosorption was conducted in the closed-loop fixed-bed column system under the temperature 70°C, pH=12.5 and a biosorbent dose of 2.5 g/L. Metal ions content in the alkalized juice after 15, 30, 45, 60, 90, 105, 120, 180 and 240 minutes was detected according to ISO 6869:2000 using the Varian, SpectrAA—10 Atomic Absorption Spectrometer. Three non-linear kinetic models including pseudo-first, pseudo-second, and Elovich were applied to the obtained results in order to get insight into the biosorption mechanism. Equilibrium regarding all three monitored molassigenic metal ions was reached after 15 minutes. Ca ions were removed from the alkalized juice in the highest amount (51.6%). Whereas monovalent Na (14.6%) and K (7.8%) ions were less successfully removed. According to the one-dimensional correlation coefficient (R^2) the most adequate kinetic models for closed loop biosorption are pseudo-first ($R^2 \geq 0.98$) and pseudo-second ($R^2 \geq 0.98$). Therefore, the biosorption process is controlled by chemisorption and ion-exchange. Under the established conditions molassigenic metal ions removal process has rapid dynamics. Successful application of the closed-loop system potentially enables scale-up of the whole system.

Keywords: Sugar beet pulp, Kinetic study, Molassigenic metal ions, Closed-loop fixed-bed column system

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