An environment-friendly multi-step membrane-based system for succinic acid recovery from the fermentation broth

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ABSTRACT

A novel environment-friendly process of recovery of succinic acid from the actual post-fermentation broth (remained after bioconversion of glycerol) in an integrated system consisting of: ultrafiltration (UF modulus equipped with two tubular ceramic membranes), two steps of ion exchange (two IE columns with a sodium IE resin), nanofiltration (NF modulus with a polymeric flat sheet membrane), and two steps of bipolar membrane electrodialysis (10-chamber large-scale EDBM with a stack consisting of 10 bipolar membranes, 10 anion-exchange, and 1 cation-exchange membranes) was investigated. As the first step the preclarification process of the actual post-fermentation solution carried out by UF was needed in order to remove high molecular contaminants such as biomass, proteins as well as cells. In turn, in the IE process the effective removal of Mg$^{2+}$ and Ca$^{2+}$ salts was obtained that allowed to significantly reduce the scaling process of the membrane in the next separation step which was the NF process. NF was efficiently employed to concentration of succinates and partial removal of other compounds, such as: monocarboxylic acids, glycerol, and lactose. The final two steps of EDBM were allowed to obtain high degree of desalination and high purity of succinic acid. By summing up the obtained results, it can be concluded that using the proposed integrated system was possible to effectively purify and concentrate the succinic acid from the actual post-fermentation broth. The final concentrate obtained after the second stage of the EDBM process contained over 18 g/L of succinic acid contaminated with only a small amount of glycerol (0.3 g/L). Furthermore, the use of the EDBM in the proposed integrated system allowed to eliminate the acidification of broth, which usually generated a considerable amount of wastes. Moreover, it should be stressed that the proposed six steps membrane-based process for the recovery of succinic acid from the actual post-fermentation broth is a totally waste-free technology.

Keywords: Succinic acid; Fermentation broth; Ultrafiltration; Nanofiltration; Bipolar membrane electrodialysis

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