

Pais, L.S., Leão, C.P., Loureiro, J.M., Santos, M., and Rodrigues, A.E.

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in *AICbE 1996 Annual Meeting*, Chicago, IL, USA, November 10-15, 1996.
(*comunicação oral*)

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Simulated Moving Bed Adsorptive Reactor: Modeling, Simulation and Operation of a SMBR pilot plant

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Adsorptive separations are becoming increasingly important in chemical industry. The simulated moving bed technology (SMB) developed by UOP has been used for various separations, namely the recovery of p-xylene from a mixture of C8 isomers (PAREX) or the separation Glucose/Fructose in the SAREX process. More recently the technology has been introduced in the area of fine chemicals and pharmaceuticals by leading companies SEPAREX and UOP.

The combination of reaction and separation processes in a single unit has been the subject of many publications although many were not successfully tested. The general idea is to displace equilibrium in reversible reactions by removing a product (by adsorption or other separation process); however, in enzymatic systems the product has sometimes to be removed because it is an inhibitor of the reaction. Also, from the adsorption point of view reactive adsorption is of interest because breakthrough time can be increased due to the coupling of nonlinear adsorption and reaction, as in carbon masks adsorptive reactors.

The system to be studied here is the production of glucose and fructose from a feed stream containing sucrose and invertase enzyme. The reaction occurs in the liquid phase and the adsorbent used in the SMB plant is a resin Amberlite 200 in the calcium form which has higher affinity to fructose. The Henry's constants at 293 K are 0.56 and 0.42 for fructose and glucose, respectively.

The methodology followed involved a first study on the SMB separation of Glucose and Fructose. A model was developed including mass balance equations for each species, axial dispersed flow assumption and linear driving force model for intraparticle kinetics. The SMB was simulated through its equivalent true moving bed. Both steady state and transient solutions were obtained by using collocation methods. The model was then extended to include a reaction term in the liquid phase. Experiments were carried out in a Simulated Moving Bed pilot plant (SEPAREX) containing 12 columns in 4 sections. The influence of switching time on performance parameters : purity, recovery and conversion were analyzed.