ADSORPTION EQUILIBRIUM OF FRUCTOSE, GLUCOSE AND SUCROSE FOR CATIONIC RESINS IN THE SODIUM AND POTASSIUM FORM

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Separation of glucose from mixtures of fructose and sucrose in molasses is a major challenge in industrial sugar chromatographic separations. The efficiency of a chromatographic process is largely dependent on the adsorbent used. Sulfonated poly(styrene-*co*-divinylbenzene) (PS-DVB) ion exchange resins are the most frequently used for sugars separation, generally in a cationic form. The cation will complex with the hydroxyl group of the sugar leading to a selective adsorption according to the orientation of the hydroxyl group. Thus, the conformation of the sugar determines its relative affinity for the resin and its distribution coefficient. Consequently, fructose forms the more stable sugar-cation complex being preferentially adsorbed in the resin followed by glucose. Sucrose interacts very weakly with the cation and is partially or totally excluded from the resin matrix owing to its larger molecular size. The separation process is usually carried out at high temperatures. However, this implies high energy costs and an elevated level of hydrolysis.

Adsorption isotherms of the sugars present in a mixture are a very important parameter for the selection of the adsorbent to be used in the chromatographic separation. Therefore, in this study, the adsorption isotherms of glucose, fructose and sucrose were determined for two resins of PS-DVB in the sodium and potassium forms. Potassium and sodium are the most recommended cations for the separation of sucrose, fructose and glucose.

The sodium and potassium resins matrix used in this work consist in meshes of 500-600 µm and 290-350 µm, respectively. Solutions with single and multi-component mixtures of the three sugars were used at 25ºC and 40ºC. A static method was used to determine the equilibrium adsorptions: 3.5 mL of solutions with different sugar concentrations were added to a known amount of adsorvent. The mixture was held for 8h under agitation and a fixed temperature and a final concentration in equilibrium with resin was determined by HPLC.

As expected, the results achieved showed that for all the conditions, fructose is the most adsorved sugar followed by glucose and sucrose.

For both resins, the increase of temperature conducted to a decrease on the adsorption constant for all the sugars in the mono-component mixtures. Nevertheless, the adsorption in multi-component mixtures was not significantly affected by the temperature in the sodium resin, and regarding the potassium resin only a small increase in the adsorption was observed.

Multi-component mixtures at 25 ºC showed a decrease in the adsorption as compared with mono-component mixtures. However, at 40ºC the adsorption observed for the multi-component mixtures was higher than the observed for the mono-component ones.

The sugars that demonstrated lower selectivity values were fructose/glucose since these sugars have the same molecular weight. Sucrose/fructose selectivity showed a higher value when compared with sucrose/glucose because of the complex formed between fructose and the resin. This profile was found for both resins used, regardless of temperature.

Selectivity of both resins decreased with the increase of the temperature values. Nevertheless, the selectivity obtained for the potassium resin was higher as compared to the selectivity obtained for the sodium resin.

In sum, potassium resin appears to be the most suitable adsorvent and an operational temperature of 25 ºC showed the best results.