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Effect of basicity of anion exchangers and number and positions of sulfonic groups of acid dyes on dyes adsorption on macroporous anion exchangers with styrenic polymer matrix

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HIGHLIGHTS

- ▶ Dye with larger number of sulfonic groups indicates faster binding with resin.
- ▶ Dye with smaller number of sulfonic groups indicates stronger affinity for resin.
- ▶ Basicity of resin does not affect rate of acid dyes adsorption.
- ▶ Basicity of resin affects significantly its adsorption capacity for acid dyes.

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ABSTRACT

Three commercial anion exchange resins, strongly basic of type 1 (Amberlite IRA-900) and type 2 (Amberlite IRA-910) and weakly basic (Amberlyst A-21) were evaluated for the removal of anionic acid dyes, C.I. Acid Orange 7 and C.I. Acid Orange 10 from aqueous solutions. The pseudo-second order kinetic model was applied to predict the rate constant of adsorption and the equilibrium capacity as a function of initial dye concentration. Modeling of kinetic results showed that the sorption process of the dye adsorption on the anion exchangers is in the good agreement with pseudo second-order model in the entire investigated concentration domain. Also kinetic measurement showed that the process was uniform and rapid. However, C.I. Acid Orange 10 demonstrated faster binding with the anion exchangers than C.I. Acid Orange 7. On the basis of the Langmuir isotherm model analysis, the maximum adsorption capacity of anion exchangers and affinity of the dyes for resins were determined. For each acid dyes, the maximum adsorption capacity of Amberlite IRA-900 was higher than the maximum adsorption capacity of remaining anion exchangers. The dyes sorption did not change in whole pH range of 2–12 in accordance with a presupposed ion-exchange mechanism of the adsorption on strongly basic anion exchangers. On the other hand, the sorption of the dyes on the weakly basic anion exchanger also did not change with changing pH suggesting physical adsorption in the polymer network and hydrogen bonding as the predominant mechanism of the dyes on this ion exchange resin.

1. Introduction

Ion exchange is used in many chemical processes, including simple or chromatographic separations and catalysis, and is well-established in analytical chemistry. Ion exchange processes are employed as well in hydrometallurgy and metal recoveries, in the manufacture of sugar, in pharmacy and medicine as well as in biochemistry and biotechnology, and in agriculture and food processing. The best known are the ion exchange phenomena in soils and the ion exchange processes used for the treatment of water [1].

Contamination of surface water and groundwater with aromatic compounds is one of the most serious environmental problems human being faces today. Dyes constitute one of these problematic groups of chemical pollutants [2,3]. Ion exchange/adsorption techniques employing solid sorbents provide an attractive alternative for the treatment of dyes contaminated waters and numerous recent works [4–23] have pointed out that ion exchangers can be successfully applied to water contaminated with a wide range of dyes. The distinct majority of these works concern the use of anion exchangers because anionic dyes classified according to the usage classification as acid, direct and reactive dyes are most common water pollutants.

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