REMOVAL OF TEXTILE DYES WITH PECTIN

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Key words: textile dyes, pectin, sorption.

Introduction. The compounds direct black 22 (DB22) and direct red 81 (DR81) are used to dye substrates such as cotton and leather. The dye disperse yellow 54 is used in dyeing of synthetic fibers such as nylon and acrylic (1). Although the water containing these dyes is treated with activated sludge and percolating filters, these compounds are difficult to be removed due to their complex chemical structure which makes them highly stable to several biological, physical and chemical treatment process. It was reported that different biodegradable materials such as chitin, chitosan, alginic acid and xanthan can remove dyes by sorption mechanism (2,3). Lozano-Álvarez et.al. reported the removal of DY54 dye (commercial and purified forms) using xanthan and alginic acid. It was also demonstrated that the sorption process fits adequately to the Zimm-Bragg model (4,5). In an attempt to extend our findings to different biopolymers, the sorption capacity of pectin was studied. A gel of pectin can be formed easily due to the interaction of Ca^{+2} and galacturonic residues (6). In addition the pectin has other neutral regions that can interact with dyes and contributes to removal of them. In this work we report the removal of the DB22, DR81 and DY54 dyes in their commercial form by the pectin.

Methods. A defined amount of pectin was added to different samples of artificial water containing textile dyes in accordance to Lozano-Alvarez et al (3, 4). Afterward the dye concentration in water was measured by UV-Visible Spectroscopy visible. The influence of pH and ionic strength on the removal of dyes was evaluated. The sorption isotherms were plotted in accordance to Zimm-Bragg model (5) as was reported by Jáuregui-Rincón et al (3).

Results. It was found that the optimal conditions of dye removal by pectin are the following (using a dye solution of 100 mg/L): DB22: pH=4-5 and Ionic strength (I) =0.1M, with a maximum removal percent (%R) of dye of 98.8%; DR81: %R= 98.6% (pH=8 and I=0.e1-0.9M) and DY54, %R= 97.6% (pH=5-6 and I=0.1 M). These conditions were used to obtain the sorption isotherms of the three dyes. In the figure 1 are plotted the Zimm-Bragg sorption isotherms of DB22, DR81 and DY54 respectively. All plots have a sigmoidal tendency which confirms that this model of describes the experimental data of all dyes. This model takes into account the nucleation (Ku) and aggregation (U) parameters which means that dye molecules tend to form aggregates and they are adsorbed on the surface of the pectin. Unfortunately the value of these parameters can´t be determined since the work was done using the commercial form of the dyes. A qualitative estimation of the Ku and U values is the following: DB22> DY54 >RD81. Taking into consideration the values of these parameters, high removal efficiencies are expected when this polysaccharide is used. Figure 2 shows that the removal efficiency of DB22 increases as the concentration of the dye increases in aqueous solution. Abbot et al reported that an increase in dye concentration facilitate dye aggregation (7), thus, the polymer-dye aggregates interaction is favored. These findings suggest that pectin can be used as removal agent of textile dyes in water.

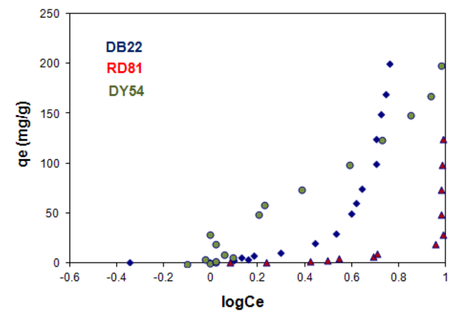

Fig.1 Zimm Bragg sorption Isotherms of DB22, RD81 and DY54 dyes with pectin as adsorbent agent.

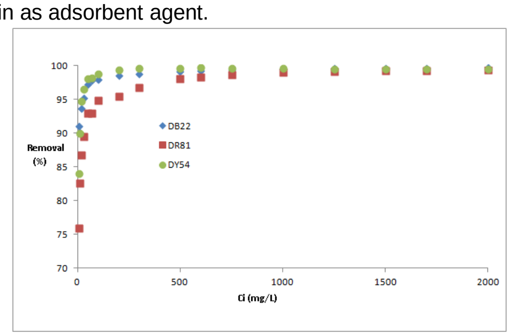

Fig.2 Removal efficiency of DB22, RD81 and DY54 dyes as function of dye concentration with pectin as adsorbent agent.

Conclusions. It was found that pectin is able to remove considerable amounts of DB22, DR81 and DY54 dyes. Our results showed that in the same way that alginic acid and xanthan, the Zimm-Bragg model can be used to describe the experimental isotherms. The principal mechanism that favors high removal efficiencies of these dyes by this polymer is the formation of aggregates and the affinity of these aggregates to the pectin surface.

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