SORPTION OF DIRECT DYES FROM AQUEOUS SOLUTION ONTO A SYNTHETIC ADSORBENT. KINETIC STUDY

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Introduction

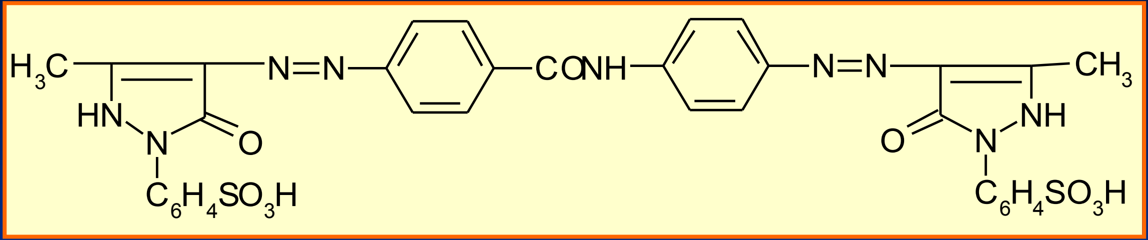
- Industries such as textile, paper, plastics, etc., use great quantities of water, and chemical substances, for coloring the manufactured articles, and discharge large amounts of wastewater during industrial processing.
- The discharge of coloured wastewater is a major environmental concern (can produce serious pollution problems) due to their poor biodegradability, carcinogenicity and toxicity.
- The adsorption process provides an attractive alternative for the treatment of dye contaminated waters because of its simplicity, selectivity and efficiency.

Aim

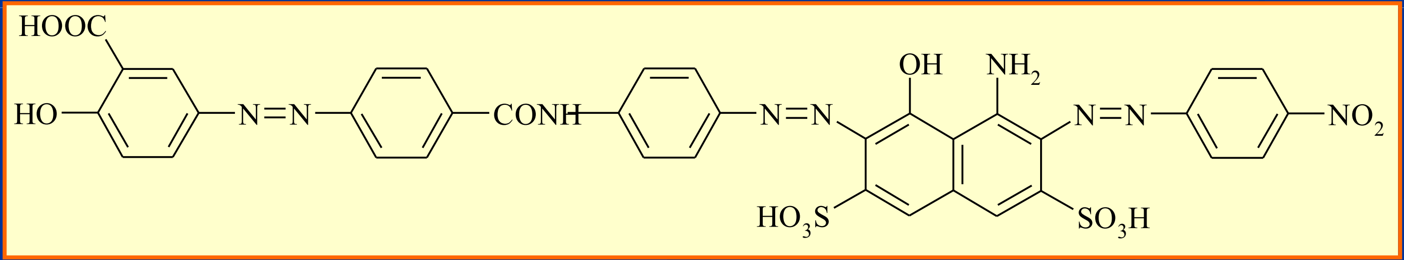
- To determine the efficiency of copolymer microbeads, as adsorbent for removal of direct dyes from aqueous solutions
- To study the influences of process variables: contact time, and initial concentration on the adsorption.
- The kinetics study of the adsorption of direct dyes onto adsorbent.

Experimental

Molecular structure of the studied direct dyes

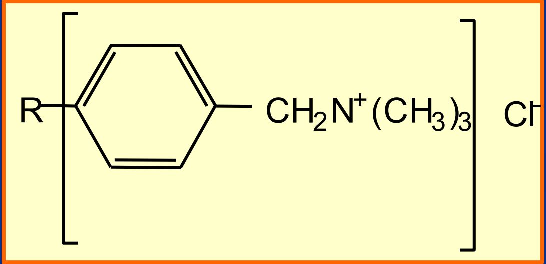


OD



GD

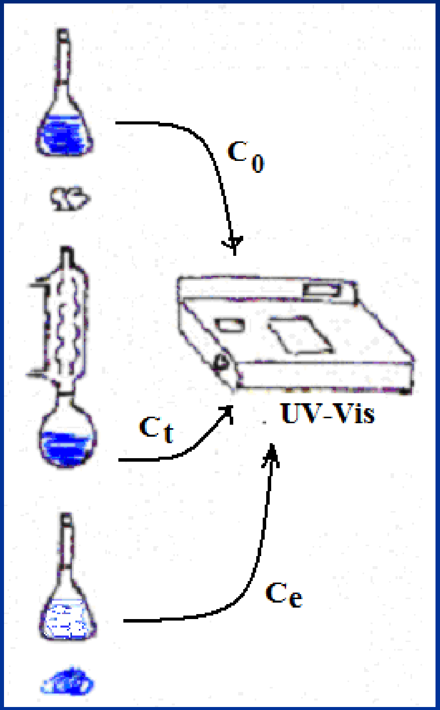
The chemical structure of investigated copolymer (*StDVBNMe*)



R: styrene-divinylbenzene copolymer

Method

Experimental study



- Dye concentration: $10^{-5} \div 10^{-4}$ M;
- Adsorbent dose 100mg/100mL;
- Temperature: 25°C;
- Solution pH: 7.11.

The amount of dye adsorbed

$$q_t = \frac{(C_0 - C_t) \cdot V}{W}$$

q_t: amount of dye adsorbed onto the copolymer unit at time *t* (mg/g),
C_0 and C_t: dye concentration in solution at initial time, and at time *t* (mg/L),
V: solution volume (L),
W: amount of copolymer (g)

The percentage of dye removal (η)

$$\eta = \frac{C_0 - C_e}{C_0} \times 100$$

C_e: dye concentration at equilibrium (mg/L).

Results and Discussions

Characterization of copolymer microbeads

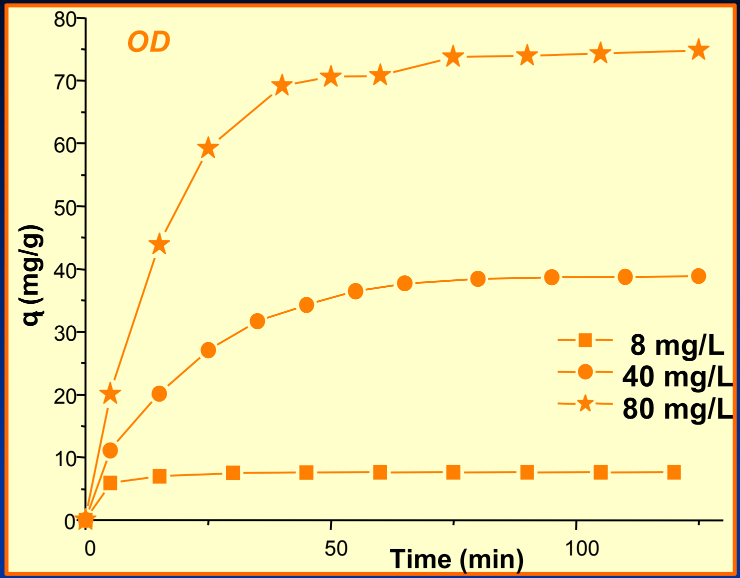
(a) (b) (c)

Fig. 1. Samples of: (a) ***StDVBNMe*** ; (b) ***OD-StDVBNMe;*** (c) ***GD-StDVBNMe***.

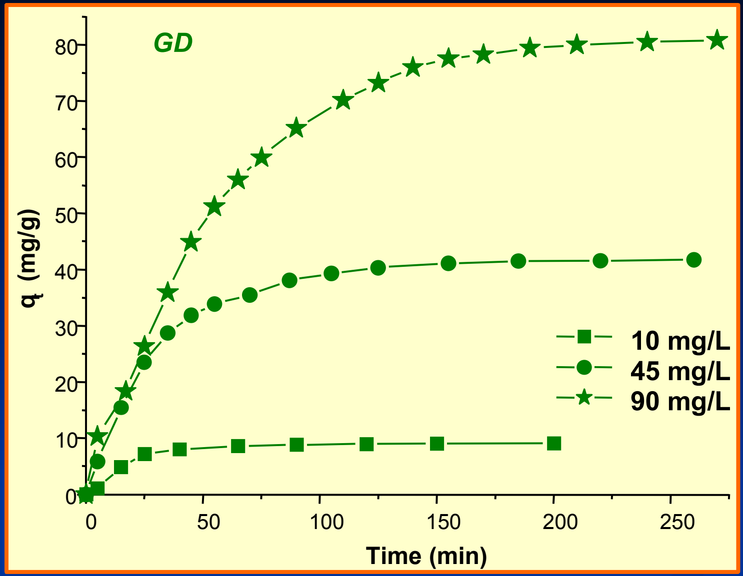
(a) (b) (c)

Fig. 2. SEM images for: (a) ***StDVBNMe***; (b) ***OD -StDVBNMe***; (c) ***GD –StDVBNMe.***

Effect of initial dye concentration and agitation time



(a)



(b)

Fig. 3. Effect of contact time and dye concentration on the percentage removal of dyes (a. *OD*, b. *GD*). *Conditions*: pH 7.11; *T*= 25±1°C, agitating speed 250rpm.

Table 1. Amount and percentage of dyes adsorbed

Dye	Dye concentration (mg/L)	q_e (mg/g)	t_e (min)	η (%)
OD	8	7.66	35	99.05
	40	39.11	75	98.13
	80	77.32	90	97.99
GD	10	9.07	65	98.53
	45	42.02	130	89.47
	90	81.48	205	88.47

Adsorption kinetics

The first-order Lagergren model

$$\log(q_e - q) = \log q_e - \frac{k_1}{2.303} t$$

The pseudo-second-order kinetic model

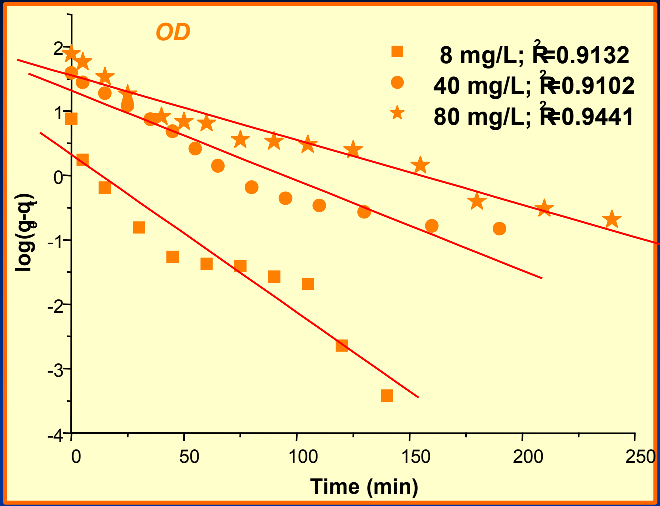
$$\frac{t}{q} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t$$

q_e, q = amount of dye adsorbed on adsorbent at equilibrium, and any time t, respectively (mg g^{-1}).

k_1 = the Lagergren rate constant of first order adsorption (min^{-1})

k_2 = the equilibrium rate constant of second-order adsorption (g mg^{-1} min^{-1})

Fig. 4. First-order-kinetics plots of the experimental data for the adsorption of *OD* and *GD* onto StDVBNMe



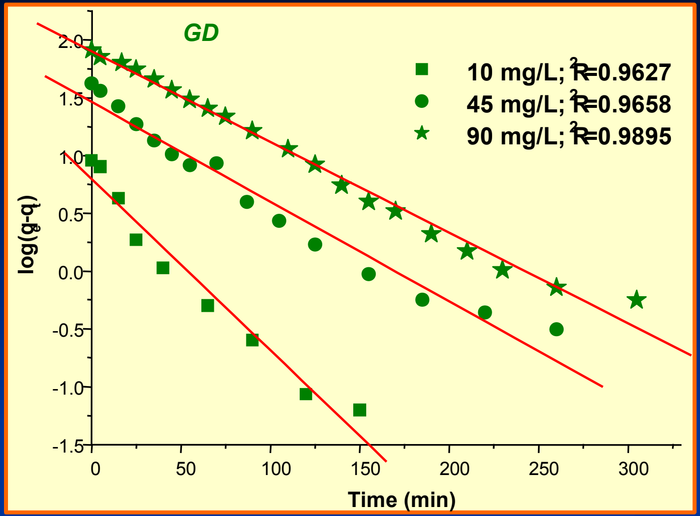
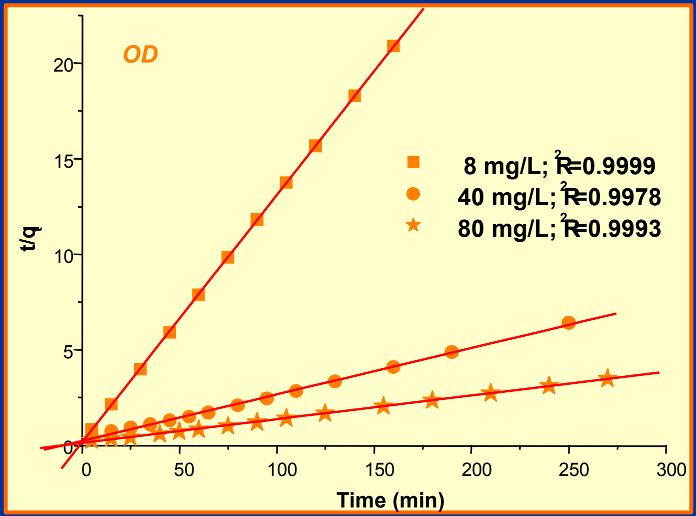


Fig. 5. Second order plots for the adsorption of *OD* and *GD* onto StDVBNMe



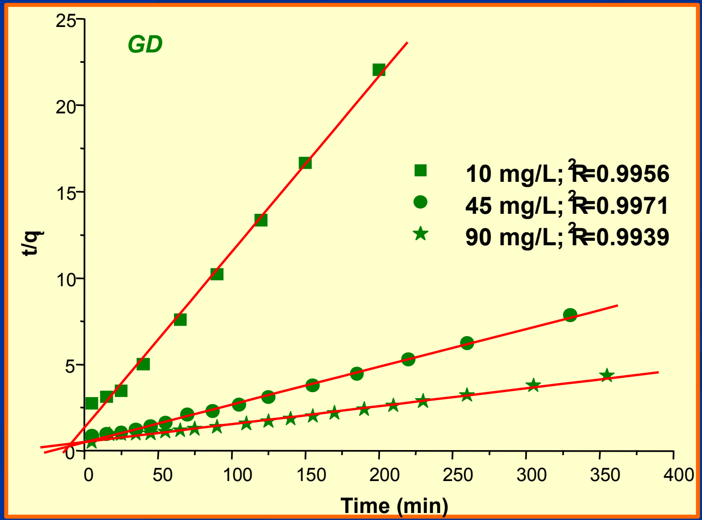


Table 4. Comparison of experimental and calculated *qe* values; first order and second order adsorption rate constant for the adsorption of *OD* and *GD* dyes

Dye	Initial dye concentration (mg/L)	q_e (exp) (mg/g)	First order kinetic model		Second order kinetic model	
			q_e (calc) (mg/g)	$k_1 \times 10^2$ (min^{-1})	q_e (calc) (mg/g)	$k_2 \times 10^2$ (g mg-1 min-1)
OD	8	7.66	2.09	5.645	7.72	11.47
	40	39.11	20.65	2.303	41.27	0.244
	80	77.32	35.6	2.309	80.26	0.134
GD	10	9.07	6.31	3.418	9.84	0.773
	45	42.02	28.95	1.985	45.81	0.096
	90	81.48	79.47	1.808	83.81	0.026

Conclusions

- **The removal of two dyes namely *OD*, and *GD* from aqueous solution by StDVBNMe was found to be effective.**
- **The StDVBNMe microbeads can by used as a adsorbent in adsorption process in low costs working conditions (room temperature, pH ~ 7).**
- **The adsorption process for *OD*, and *GD* dyes removal, can be described by the pseudo-second order kinetic model.**


Thank you
for your
attention!