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Removal and decolorization Adsorption study of dye bearing textile effluents by Sulfinated Urea-Formaldehyde resin

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ABSTRACT

Textile effluent was collected and treated with various mixtures of sulfinated urea-formaldehyde (SUF) resin, rice husk, bagasse and animal charcoal. The resultant liquids were almost colorless with very low COD. The sludge can also be used for other purpose, like pigmentation as well as filler for plastic manufacturing. Such adsorbents may have entity in environmental science. The dye absorption behaviour of this resin were evaluated by varying conditions like dye concentration, contact time and pH, weight and temperature. The Langmuir and Freundlich models were used for data description.

Keywords: Sulfinated resin, Adsorption study, Textile effluent, Langmuir and Freundlich model, Urea-formaldehyde resin.

INTRODUCTION

Commercial dyes are extensively used in applications fibers and non-textile materials [1,2]. Most of classes of dyes manufactured are azo, reactive and vat dyes[3]. The most of dyes have complex aromatic segments. So the conventional and microbial methods for treatment of dye effluent covers various methods including oxidation, separation and adsorption methods[4-8]. One of the suitable method is well established is adsorption of aqueous dye effluent by activated carbon. Such study is extended for various dyes [9-14]. The study who suggest that adsorption efficiency of dye is dependent on quality of activated carbon, dye amount and type of dye[15]. Other low cost biomaterials and industrial waste have also applied for dye adsorption[16].

H. S. Patel et al., have developed recently[17] some polymers adsorbents which could potentially effective for removal both of dye and its coloration. In continuation [17], the present work comprises the study of dye adsorption from textile effluents by use of sulfinated urea-formaldehyde resin.

MATERIALS AND METHODS

All the necessary reagents used were purchased locally. Dye effluent was collected from Surat textile industrial work, Gujarat, INDIA. Dye content of effluent was determined by evaporation method. According to the content the dye effluent was adjusted to 500mg/L concentration by dilution.

Preparation of the sulfinated urea-formaldehyde resin as sorbent

The sulfinated urea-formaldehyde was prepared by method reported[18-20].

Preparation of mixture

Four various adsorption mixtures were prepared with sulfinated urea formaldehyde resin, rice husk, bagasse, animal charcoal etc. these materials are designated as AM-1, AM-2, AM-3, AM-4 (AM-Adsorption mixture) respectively. The composition of each adsorption mixture is shown in **Table-1**:

Table-1 Various adsorption mixtures

Adsorption Mixture	SUF	Rice husk	Bagasse	Animal charcoal
AM-1	70	10	10	10
AM-2	60	20	10	10
AM-3	50	30	10	10
AM-4	40	40	10	10

Dye adsorption experiments

The so-called experiments were carried out n 100 ml erlenmeyer flask . The adsorption mixtures (AM-1 to AM-4) 1.0 g was taken and 50ml of dye effluent containing 25mg of dye amount was added with magnetic needle. The flask was placed on magnetic stirrer and the mixture is stirred for various intervals at pH 6. Each interval (in minutes) the dye concentration was deterimed spectroscopically. Similarly at equilibrium state. The experiment was carried out with various dye concentrations.

RESULTS AND DISCUSSION

Adsorption behavior of the dyes

The SUF resin is adduct with sodium bisulfite which may responsible for dye uptake as well as color removal.

Effect of pH:

The effect of hydrogen ion concentration on uptake of effluent by adsorption mixture (AM-1) is shown in **Figure-1**, while the data for all composite were displayed in **Table-2**. The plot exhibit different behaviours related to ionic groups of adsorbent. The equilibrium adsorption of effluent at different pH values exhibits a constant value of uptake percentage with increasing pH value upto ~ 6 clarifying a negligible effect over this range. At higher values, the adsorbability falls sharply with pH increase. The revealed phenomena can due to solute ionization[21]. At the initial stage, the degree of effluent ionization, which acts as weak acid in aqueous solutions, as a function of pH value seems to be independent and attains an equilibrium state with increasing the pH values from upto 6. Hence, the adsorption is slightly affected over pH range amounts to the dissociation constant value of effluent (pKa = 9.98). At higher values (pH > pKa), the degree of effluent ionization increase and the adsorbent surface becomes negatively charged. Owing to the repulsive forces prevailing between adsorbent surface and solute molecules, the adsorption extent decreases. This avouches that the solution pH value has adverse effect on the adsorb ability of effluent at values greater than its pKa value.

Table-2 Effect of pH on adsorption of dye effluent

pH	Adsorption of dye % in presence of Resin [q_α (mg/g)]			
	AM-1	AM-2	AM-3	AM-4
2	56	53	50	47
4	74	70	65	62
6	91	89	84	77
8	77	73	67	65
10	54	51	47	41
12	32	27	20	16

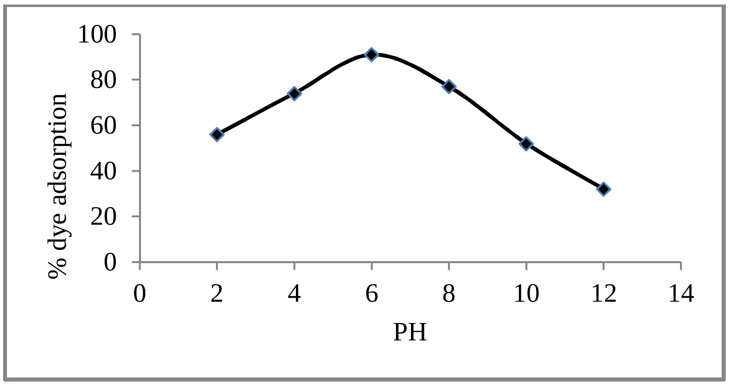

Figure-1: Dye adsorption by asorption mixture (AM-4) from effluent over different pH range, Co=100 % dye conc., Mass = 500 mg/L, Volume = 50 ml and Time = 24hr

Effect of weight on adsorption mixture:

Various adsorbent weight effect on the removal efficiency of effluent studied was using different adsorbent mixture weights ranged from 0.25-2.0 g. The results show that for removal of effluent in 10 ml with initial concentration 100 mg/L of stock solution. The data obtained are given in **Table-3** from which **Figure-2** for AM-1 composite shows that, the removal efficiency increases with increasing the adsorbent weight up to a certain dose, where the removal curve becomes steady. The further additions of adsorbent were found to have appreciated effect on the removal efficiency. The amount of effluent adsorbed per unit weight of adsorbent decreases with increasing the adsorbent weight[22].

Table-3 Effect of composite material on the residual concentration of effluent by adsorption mixture at pH-6

Mass (mg)	% of dye Concentration			
	AM-1	AM-2	AM-3	AM-4
0.25	90	82	75	69
0.50	65	58	52	46
0.75	44	38	32	27
1.0	25	18	15	11
1.25	12	7	5	6
1.50	4	2	1	1
1.75	0	0	0	0
2.0	0	0	0	0

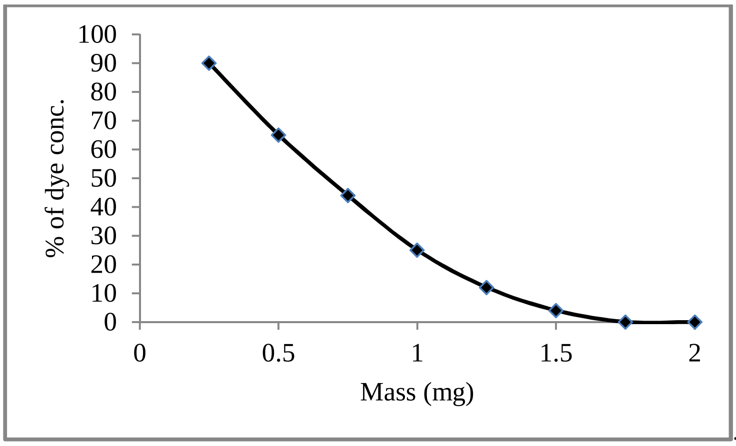

Figure-2: Effect of composite material on the residual concentration of effluent by adsorption mixture (AM-4)
Co=100 % dye conc., Mass = 500 mg/L, Volume = 50 ml and Time = 24hr

Effect of contact time:

The adsorption data for the uptake of effluent versus contact time at 100 mg/L initial concentration on 25 mg of adsorption mixture were carried out. The equilibrium time required for the adsorption of effluent on adsorption mixture (AM-1) is illustrated in **Figure-3**. The data given in **Table-4** imply that the adsorption extent increases with elapsed time till reached saturation level where the uptake percentage attains a constant value. The data from **Figure-3** clarify that the adsorption of effluent on the composite material attains the saturation level after 24 hours.

Table-4 Rate of dye uptake from effluent by adsorption mixture (AM-1)

Time (h.)	Concentration of dye %			
	AM-1	AM-2	AM-3	AM-4
1	52	40	35	28
2	59	46	39	33
4	64	53	45	40
8	76	66	58	51
16	85	74	67	61
24	92	82	75	70
48	92	82	75	70

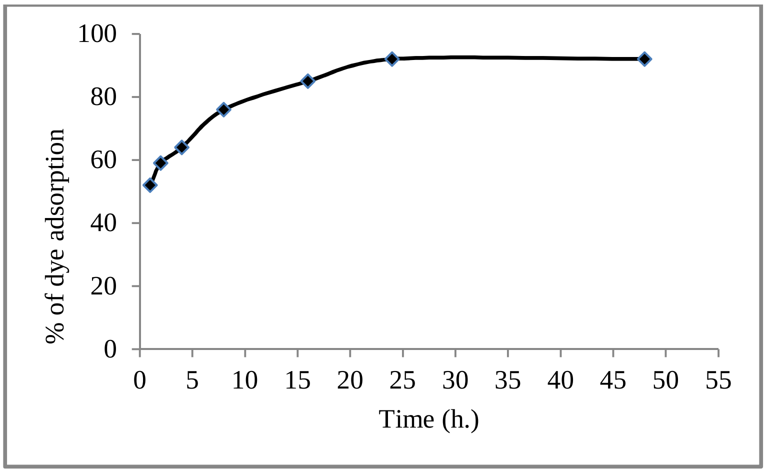

Figure-3: Effect of contact time on the residual concentration of effluent by adsorption mixture (AM-1) Co=100 % dye conc., Mass = 500 mg/L, Volume = 50 ml and Time = 24hr

Effect of temperature:
The adsorption studied for effluent onto adsorption mixture at different temperatures is displeyed in **Figure-4** and **Table-5** for AM-1 composite depicts the equilibrium adsorption of effluent onto a adsorption mixture at different temperatures. It was found that the adsorbed amount decreased with increase in temperature suggest the exothermic adsorption process. Generally, the adsorption of contaminants from aqueous solutions is related with the system temperature, where both the adsorption rates as well as the sorption capacity are affected[23]. The increase in temperature results into the increase in solubility and decrease in chemical potential of the adsorbate [24]. On the other hand, if the temperature has the revere effect, then solubility and chemical potential will progress in the opposite direction.

Table-5 Absorption isotherm of effluent by adsorption mixture (AM-1) at various temperatures

Temp.	AM-1						
298 °K	Ce (mg/L)	0.5	1.5	2.1	3.6	5.4	15.0
	q_α (mg/g)	29	41	80	126	145	162
313 °K	Ce (mg/L)	0.5	1.7	3.1	5.4	7.7	18.5
	q_α (mg/g)	26	39	75	112	132	151
323 °K	Ce (mg/L)	0.5	1.9	3.5	6.7	12.9	28.7
	q_α (mg/g)	26	38	71	102	125	136
338 °K	Ce (mg/L)	0.5	2.3	4.7	9.9	15.1	31.9
	q_α (mg/g)	25	37	66	95	120	130

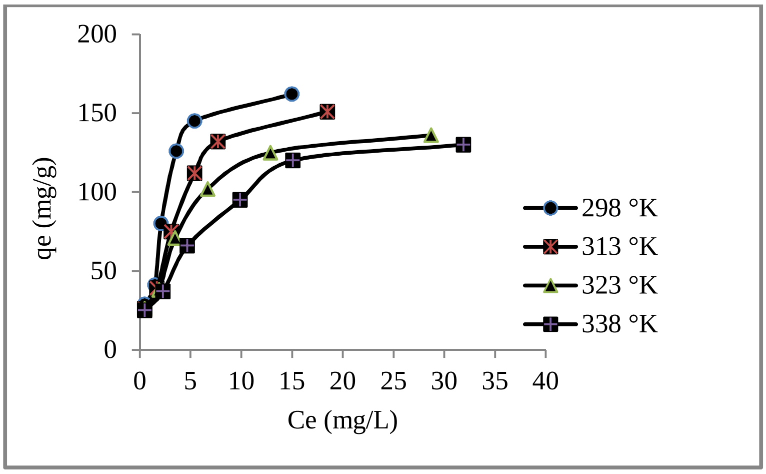

Figure-4 Absorption isotherm of effluent by adsorption mixture (AM-1) (V/m = 200 ml g^{-1}) at different temperatures

Study on effect of dye content in effluents:
In this study the fixed amount of Am-1 to AM-4 was stirred with various concentration of dye effluent. The dye adsorption by AM-1 to AM-4 was calculated by expression:

$$q_e = \frac{(C_O - C_e) \times V}{W} \qquad (1)$$

Where Co and Ce are the initial solution concentration (mg/L) and equilibrium concentration (mg/L), respectively; V is the volume of the solution; and W is the weight of the dry SUF resin (g).

The Langmuir and Freundlich models [25,26] were used to describe the relationship between the amount of dye adsorbed and its equilibrium concentration in solution. However, when the Langmuir isotherm model was applied to these systems, the regression coefficient (R20 s) values were found to be 0.4512, 0.3948, 0.5117 and 0.4782 for different adsorption mixture Therefore these results are not suitable for describes the adsorption of these basic dyes. The logarithmic form of the Freundlich model is given by the following equation:

$$\log q_e = \log K_f + \frac{1}{n} \log c_e \qquad (2)$$

where K_f and n are Freundlich constants related to the adsorption capacity and adsorption intensity, respectively. When log qe was plotted against log Ce, a straight line was obtained with slope 1/n, which showed that the adsorption followed a Freundlich isotherm well. The parameters of the Freundlich isotherm, K_f, which is calculated from the intercept of the plots, and n and R_2. R_2's indicate whether the Freundlich isotherm is applicable for a system or not. The R_2 values were 0.9787, 0.9771, 0.9762 and 0.9775 for AM-1, AM-2, AM-3 and AM-4, respectively. n values between 1 and 10 indicate beneficial adsorption[27-29]. For the adsorption of textile effluent over the surface of SUF-resin, where value of n is always greater than 1, but above the critical beneficial adsorption the value of n = 1.

CONCLUSION

The bisulfite is well known reducing agent so UF resin was treated with bisulfite. The adduct is suitable for adsorption of dye as well as removal of dye color. Hence the study includes the preparation of adsorption mixture, industrial dye effluent collection, dye adsorption by AM-1 to -4, at varies intervals, route at by uptake and effect of pH on dye adsorption.

It is suggested that use of such type of adsorption material for industrial dye effluent, may decrease the dye pollution up to some extents.

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