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Removal Dye Color from Aqueous Solution By Adsorption

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Abstract : The textile, paper and pulp, paint, printing and cosmetic industries contain significant amount of the dyes and the dye wastes must be treated to bring down their concentration to permissible limit before discharging into water bodies as required by environmental save. In this research work, the reducing color of aqueous dye solution was studied. The aqueous Congo red dye solution was prepared in laboratory. The geosorbent, quicklime powder was collected from Htone-bo Village, Patheingyi Township, Mandalay Region. The removal of Congo red from aqueous dye solution was carried out by using quicklime powder as adsorbent. The adsorption methods, standing and shaking methods were used. The adsorption isotherms were also studied.
Keywords : adsorption, dye, quicklime,Congo red, geosorbent.

Introduction

Water pollution represents a great challenge and quicklime powder, marble powder and limestone powder are adsorbent used to remove colour from dye work. Dyes are coloured compounds suitable for colouring textiles, wood, leather paper and fibres. Natural dyes such as indigo have been used for over 5000 years. Synthetic dyes have replaced natural dyes because of their low cost and vast range of new colours (Gabriel and Hong, 2008).

The increasing occurrence of many synthetic and natural organic substances in natural water led to the importance of using adsorption technique. The adsorption is one of the most effective methods of removing colour from dye waste, because several dyes cause the colour of water layer. Adsorption is a major industrial separation technique for the purification of effluent media. (Wang *et al*., 2005).

It is a mass transfer operation through which a solid material can selectively remove dissolved components from an aqueous solution by attracting the dissolved solute to its surface. This separation technique

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finds wide application in the removal of dye from aqueous media. Specifically, adsorption finds application in textile, leather dyeing, cosmetics, plastics food and paper industries where water recovery is very essential (Wang *et al*., 2005).

Dye waste needs to be treated for the protection of human health and environmental safety. Recently the removal colour from dye waste through adsorption techniques has proved promising due to its simplicity, inexpensiveness and efficiency (Wang *et al*., 2010).

In this research work, the colour removal of dye wastes using geosorbent was carried out by adsorption method.

Materials and Methods

Sampling

The Congo red dye solution was prepared in Laboratory. The geosorbent, quicklime powder was collected from Htone-bo Village, Patheingyi Township, MandalayRegion.The quick lime powder was sieved by using 100 and 120 mesh size sieves and stored in plastic bag and used throughout the research.

Figure -1 Congo red Dye Solution

Figure -2 Quick Lime Powder

Removal of Congo Red Dye by Adsorption Using Quicklime Powder

Standing Method

1 g of quicklime powder was added into 100 ml of (5 mg/L) aqueous Congo reddye solution in a conical flask. The mixture was allowed to stand for 2 hr. Then, the mixture was filtered and the filtrate was obtained. The absorbance of the filtrate was measured by UV-visible spectrophotometer at wavelength (497 nm). Then, the equilibrium concentration of dye solution was determined.

Similarly, the procedure was repeated for standing time 4 hr, 6 hr, 8 hr, 10 hr respectively. The percent removal was calculated.

Figure -3 Congo Red Dye Solution After Standing with Quicklime Powder

Shaking Method

1 g of quicklime powder was added into 100 ml of 5 mg/L aqueousCongo red dye solution in a conical flask. The mixture was shaken for 30 min at 180 rpm. Then the mixture was filtered and the filtrate was obtained. The absorbance of the filtrate was measured by UV-visible spectrophotometer at wavelength 497 nm. Then, the equilibrium concentration of dye solution was determined.

Similarly, the procedure was repeated for shaking time 60 min,90min, 120 min, 150 min respectively. The percent removal was calculated.

Figure -4 Congo Red Dye Solution After Shaking with Quicklime Powder

Study the Adsorption Isotherms

Adsorption Isotherms for Congo red dye onto quicklime in standing and shaking method werealso studied.

Results and Discussion

The color removal of aqueous Congo reddye solution using quicklime powder was examined by standing method and shaking method. The experimental data were shown in Table (1) and Table (2).

Table (1) Effect of Contact Time on Aqueous Solution of Congo Red Dye by Quicklime Powder (Standing Method)

No.	Mass of adsorbent (g)	Contact time (hr)	Initial conc: C_0 (mgL^{-1})	Equilibrium conc: C_e (mgL^{-1})	Percent removal (%)
1.	1.00	2	5.00	1.84	63.20
2.	1.00	4	5.00	1.58	68.40
3.	1.00	6	5.00	1.36	72.80
4.	1.00	8	5.00	1.23	75.40
5.	1.00	10	5.00	0.88	82.40

Table (2) Effect of Contact Time on Aqueous Solution of Congo Red Dye by Quicklime Powder (Shaking Method)

No.	Mass of adsorbent (g)	Contact time (min)	Initial conc: C_0 (mgL^{-1})	Equilibrium conc: C_e (mgL^{-1})	Percent removal (%)
1.	1.00	30	5.00	1.05	79.00
2.	1.00	60	5.00	0.88	82.40
3.	1.00	90	5.00	0.53	89.40
4.	1.00	120	5.00	0.26	94.80
5.	1.00	150	5.00	0.18	96.40

From the Table(1) and Table (2), the percentage of color removal was the high using quicklime as adsorbent in shaking method. Therefore, the quicklime powder was used as the adsorbent in this research.

Adsorption Isotherms for Congored Dye onto quicklime in standing and shaking method, was studied.

Table (3) Adsorption of Congo Red Dye onto Quicklime Powder (Standing Method)

No	Contact time(hr)	C_e (mgL^{-1})	q_e (mgg^{-1})	C_e/q_e (gL^{-1})	log [C_e(mgL^{-1})]	log [q_e(mgg^{-1})]
1.	2	1.8400	0.3160	5.8228	0.2648	– 0.5003
2.	4	1.5800	0.3420	4.6199	0.1987	– 0.4660
3.	6	1.3600	0.3640	3.7363	0.1335	– 0.4388
4.	8	1.2300	0.3770	3.2626	0.0899	– 0.4237
5.	10	0.8800	0.4120	2.1359	– 0.0555	– 0.3851

By using these data, Langmuir and Freundlich isotherm were studied.

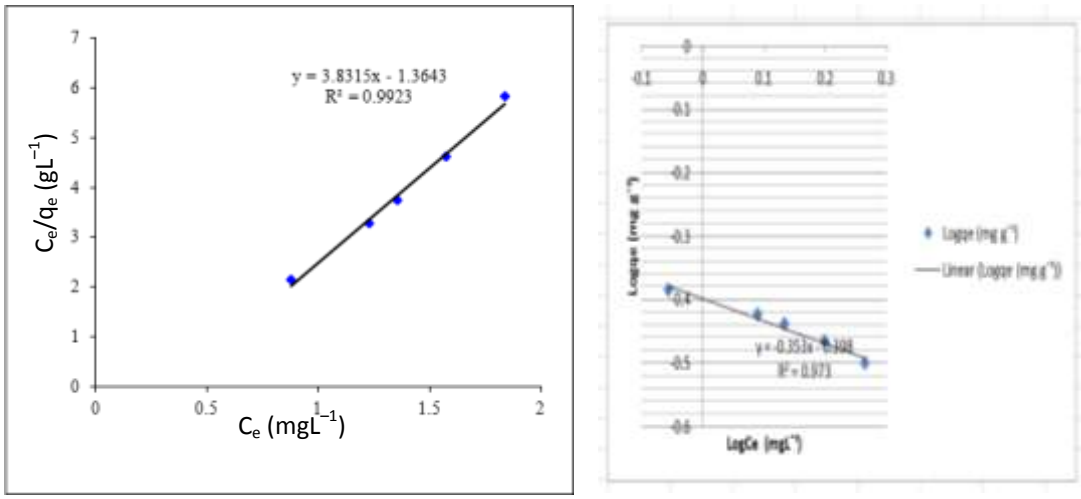

Figure 1 (A) Langmuir Isotherm (B) Freundlich Isotherm (Standing Method)

Table (4) Adsorption of Congo Red Dye onto the Quicklime Powder (Shaking Method)

No.	Contact time (min)	C_e (mgL^{-1})	q_e (mgg^{-1})	C_e/q_e (gL^{-1})	log [C_e(mgL^{-1})]	log [q_e(mgg^{-1})]
1.	30	1.0500	0.3950	2.6582	0.0212	– 0.4034
2.	60	0.8800	0.4120	2.1359	– 0.0555	– 0.3851
3.	90	0.5300	0.4470	1.1857	– 0.2757	– 0.3497
4.	120	0.2600	0.4740	0.5485	– 0.5850	– 0.3242
5.	150	0.1800	0.4820	0.3734	– 0.7447	– 0.3170

By using these data, Langmuir and Freundlich isotherm were studied.

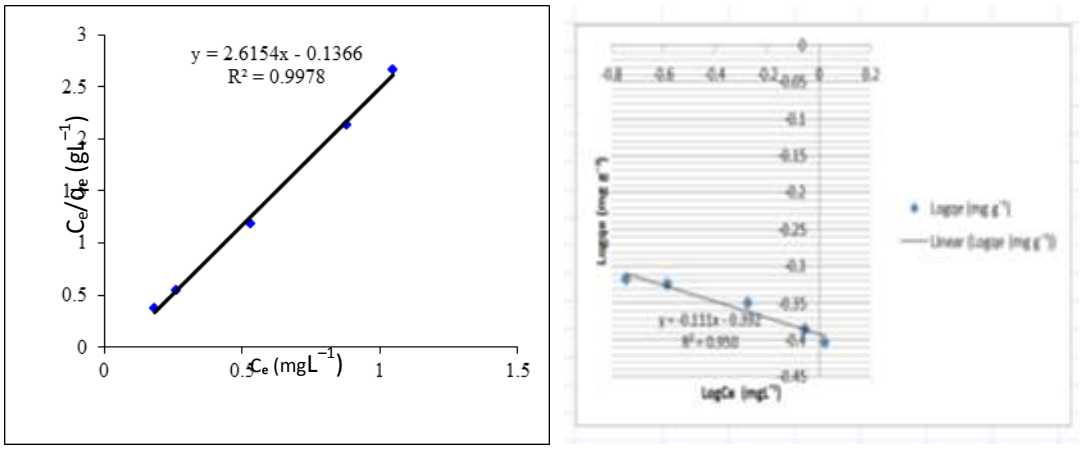

Figure 2 (A) Langmuir Isotherm (B) Freundlich Isotherm (Shaking Method)

Table (5)Langmuir and Freundlich Parameters for the Adsorption of Congo Red Dye onto the Quicklime Powder

Method	Langmuir parameters			Freundlich parameters		
	R^2	Monolayer coverage,X_m (mgg^{-1})	Langmuir constant,b (Lmg^{-1})	R^2	Sorption intensity,n (Lmg^{-1})	Sorption capacity,k ($g^{-}mg^{1}$)
standing	0.9923	0.7330	0.3560	0.973	2.8329	0.3999
shaking	0.9978	7.3210	0.052	0.950	9.0090	0.4055

The obtained $X_m$from Langmuir model showed that the adsorbent would have the acceptable capacity for Congo red adsorption. The values of sorption intensity in the Freundlich model indicated a high tendency toward adsorbing the dye onto the adsorbent. This shows that the surface of the adsorbent is heterogeneous and the adsorption of Congo red dye on the adsorbent is multilayer.

Conclusion

In this research work, the Congo red dye aqueous solution was prepared in laboratory. From the adsorption of Congo reddye on quicklime powder by standing method and shaking method, it was found that the color removal of dye using quicklime powder was high as the adsorbent for the adsorption study.

The reducing color intensity of aqueous Congo red dye solution was determined by using quicklime as adsorbent. It was observed that the color intensity of dye solutions could reduce in standing method and shaking method.

From the study of the adsorption isotherm, the obtained X_m values from the Langmuir model showed that the adsorbent would have an acceptable capacity for Congo red dye adsorption and the adsorbent would have high compliance with the Freundlich isotherm from R^2 values.

Therefore, the quicklime powder should be used as the adsorbent for the adsorption to remove the dye color of dye wastes to save the environmental pollution.

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