

## Effect of pH on the removal of Victoria blue by adsorption

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### ABSTRACT

The removal of Victoria blue dye from water and waste water by adsorption on China clay is greatly influenced by the pH of the medium. The pH of the adsorbate solution affects the nature of the surface properties of adsorbents, the degree of ionization and speciation of aqueous adsorbate species and ultimately the rate and extent of the adsorption. The initial concentration of the dye taken was  $1.0 \times 10^{-6}$  M and the China were agitated at  $30^\circ\text{C}$  ( $\pm 0.1^\circ\text{C}$ ). The pH of the dye solution was changed from 3.0 to 8.0 using NaOH or HCl solutions of appropriate strength. The results of the variation in adsorption with different pH have been recorded.

**Key words:** Lead (Plumbum) litharge, red lead, lead hydroxide, Haem synthesis.

### INTRODUCTION

Through various methods viz. chemical oxidation, Froth flotation and coagulation have been employed for colour removal, adsorption offers the best for removal of wide ranging pollutants such as dissolved solids, heavy metals and organic dyes. Activated carbons were widely used as an adsorbent, though it is quite expensive which resuscitates to explore low cost adsorbents. The aim of this paper is to use cheaper adsorbent i.e. china clay to its high efficiency, easy handling and less expensiveness for the removal of Victoria blue from water.

### EXPERIMENTAL

Batch adsorption experiments were performed in a shaking incubator by agitating different glass bottles containing 1.0 g of adsorbent in 50 ml aqueous solution of Victoria blue at desired concentration at  $30^\circ\text{C}$  ( $\pm 0.1^\circ\text{C}$ ) and 3.0 to 8.0 pH. The pH of the dye solution was changed from 3.0 to 8.0 using NaOH or HCl of appropriate strength. The results showing the variation in adsorption and desorption of Victoria blue with corresponding pH has been recorded in Table -1 and is shown graphically in Fig. -1.

### RESULTS AND DISCUSSION

It is evident from the results (i.e., table 1 and Fig. -1) that the pH of the medium has greatly influenced the uptake of Victoria blue by China Clay through the basis nature of time variation curve remains the same. The rate as well as the total amount of Victoria blue adsorbed at pre-equilibrium and equilibrium stages vary with change in pH of the solution to different extent. However, the time required to attain the equilibrium does not change to any appreciable extent with the change in pH. The amount of Victoria blue adsorbed (cf table-1 and Fig. -1) change from 0.0085 to 0.2160, the change in pH from 3.0 to 8.0 at initial dye concentration of  $1.0 \times 10^{-6}$  M and temperature  $30^\circ\text{C}$  ( $\pm 0.1^\circ\text{C}$ ). Similar findings were reported earlier by several workers.

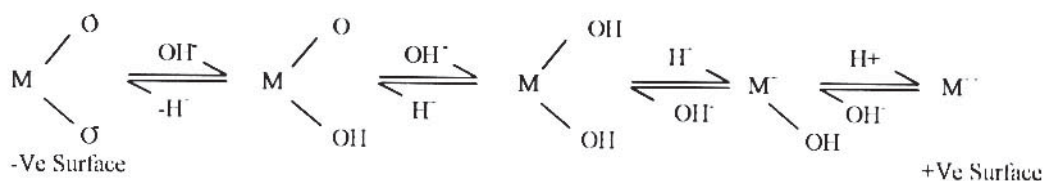
The increase in rate as well as the extent of adsorption of dye cations on China clay may be explained on the basis of the formation of surface hydroxyl components and their subsequent acid base dissociation which give the +ve or -ve charged surface depending upon the pH of the medium. The variation in amount absorbed at different pH values can also be explained on the basis of change in surface electrical force and

**Table -1: Time variation of adsorption of Victoria blue on china clay at different pH values**  
**Concentration:  $1.0 \times 10^{-6}$  M Temperature :  $30 \pm 0.1^\circ\text{C}$  Particle size  $< 53\mu\text{m}$**

Time (min)	pH 3.0		pH 5.5		pH 7.0		pH 8.0	
	Amount Adsorbed ( $\text{mg g}^{-1}$ )	% Ads.	Amount Adsorbed ( $\text{mg g}^{-1}$ )	% Ads.	Amount Adsorbed ( $\text{mg g}^{-1}$ )	% Ads.	Amount Adsorbed ( $\text{mg g}^{-1}$ )	% Ads.
5	0.00079	3.24	0.00183	7.50	0.00378	15.25	0.00455	18.01
10	0.00120	4.00	0.00245	10.01	0.00495	19.92	0.00620	25.02
20	0.00200	8.08	0.00345	13.99	0.00692	27.92	0.01120	45.04
40	0.00300	12.19	0.00482	18.75	0.00925	37.23	0.01680	67.56
60	0.00340	13.75	0.00520	21.02	0.001065	42.84	0.1810	72.57
80	0.00376	15.11	0.00499	20.06	0.001145	46.02	0.02199	80.08
100	0.00389	15.97	0.00640	25.86	0.001193	47.90	0.02160	86.58
120	0.00399	16.01	0.00640	25.86	0.001193	47.90	0.02160	86.58
140	0.00378	15.49	0.00641	25.92	0.001190	47.96	0.02160	86.58
160	0.00389	15.97	0.00642	25.82	0.001195	47.90	0.02160	86.58
180	0.00382	15.49	0.00641	25.92	0.001193	47.96	0.02160	86.58
200	0.00385	15.49	0.00640	25.82	0.001194	47.96	0.02160	86.58

charged particles in the vicinity of the adsorbent. The hydroxylated oxide present in the China clay

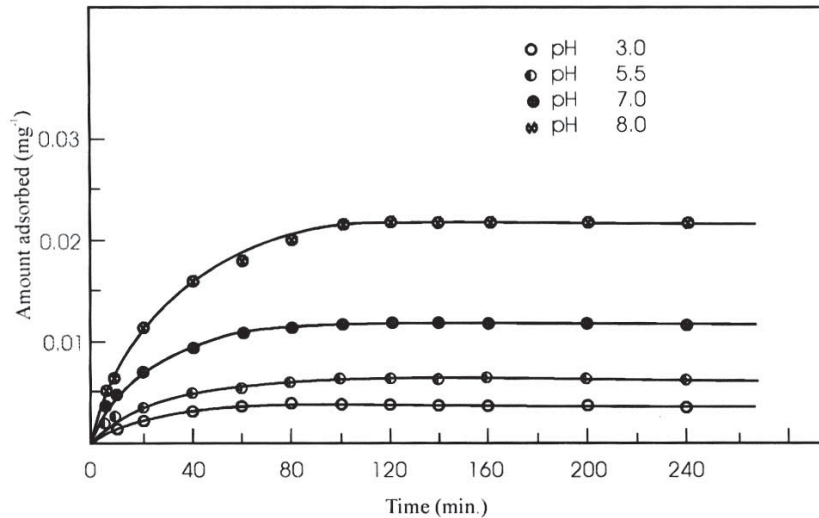
develops electrical charges at the solids solution interface in the following manner.



Where, M represent Al, Si and Ca etc. The adsorbents used in this present study mainly contain the oxides of silicon and Aluminum as aluminosilicate ( $\text{Si}_4\text{Al}_4\text{O}_{10}(\text{OH})_8$ ). These oxide surfaces are expected to behave differently in acidic and alkaline medium due to their different surface charges and different types of orientations in the presence of varying amount of  $\text{H}^+$  and  $\text{OH}^-$  ions with increase in pH of the solution, the surface negative charge increase and hence the extent of adsorption of Victoria blue cations increases with increase in pH. However, at lower pH, in acidic medium, the oxide

surface will be positively charged resulting in unfavorable conditions for the adsorption of dye cations. It has been suggested that the adsorption of cations at the solid solution interface is governed by the strongly adsorbed hydroxo, sulphato, carboxylato and other metal species.

The enhanced removal of Victoria blue is mainly attributed to the presence of  $\text{OH}^-$  ions in the adsorbate solution in alkaline medium. Manzel and Coworkers have suggested that the presence of one hydroxyl ion would force one adsorbed cation



**Fig. - 1: Time variation of adsorption of victoria blue on China clay at different pH values; Concentration:  $1.0 \times 10^{-6}M$ ; Temperature:  $30^{\circ}C$**

to be more readily ammoniated in the surface lattice followed by further adsorption.

The zero point charges of alumina and Silica are 8.3 and 2.2 respectively. Thus, the surface of alumina in China clay possesses positive charge at low pH range, which is unfavorable for the interaction of cations.

The findings are quite useful in developing an appropriate technology for designing

a waste water treatment plant where in such unconventional materials could be utilized as potential adsorbents.

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#### REFERENCES

- Eckenfelder, W.W. Jr and O'Connor. D.J. "Biological waste treatment", Pergman Press, New York (1961).
- Hudson, H.E. Jr., J. Amer Water Works Assoc. **57**, 855 (1965).
- Bhargava, R.Mathur, R.P. and Khanna, P. Indian J. Env. Health, **16**, 109 (1974).
- Pandey, K.K., Prasad, G. and Singh, V.N., Indian J. Chem. **23A** 514 (1984).
- Mekay, G. Otterburn, M.S. and Jamal, A.A., Water, Air and Soil Pollut, **24**, 307 (1985).
- Khare, S.K., Pandey, K.K, Srivastwa, R.M. and Singh, V.N., J. Chem. Tech. Biotechnol. **38**, 99 (1987).
- Rai, A.K., Ph D. Thesis Banaras Hindu University, India (1995).
- Khatri, S.D. and Singh M.K., Indian J. Chem. Technology **6**, 112 (1999).