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REMOVAL OF COD OF REACTIVE DYES USING POLY ALUMINIUM CHLORIDE

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ABSTRACT

Textile manufacturing units involved in finishing processes are profuse water consumers. The effluents from these plants are major source of water pollution. Poly Aluminium Chloride ($AlCl_3$ $6H_2O$) is used as a coagulant for the removal of Chemical Oxygen Demand (COD) of selective reactive dyes, which are used for cotton yarn dyeing, at different doses. The results indicate that the removal of COD of various dyes RB41, RB209, RB204 and RB184 are 68, 40, 36, and 29 percent, respectively at their optimum doses. The optimum doses of Poly Aluminium Chloride (PAC) for RB41, RB209, RB204 and RB 184 are 5.2, 34.3, 20 and 22mg of PAC per mg. of COD removed, respectively.

Keywords: poly aluminium chloride coagulant, reactive dye removal, coagulation, flocculation.

INTRODUCTION

The amount of dyes discharged into the environment from the textile industry is about 146,000 tons per year (Marc, 1996). Reactive dyes are the most commonly applied, among more than 10,000 dyes applied, in the textile processing industries (Vander zee, *et al*., 2001). Reactive dyes are particularly problematic in dye wastewaters as many of these are resistant to biodegradation processes (Grau, 1991).

Chemical Oxygen Demand (COD) is a measure of oxygen requirement of a sample that is susceptible to oxidation by strong chemical oxidant. Combined methods, such as activated sludge + coagulation activated sludge + adsorption and coagulation + chemical oxidation are being used by most dyeing industries in the effluent treatment (Lin and Chen, 1997, Popali *et al*., 2002). Ferric chloride, aluminum chloride, and lime + ferrous sulphate are widely used as coagulants for dye colour removal with varying degrees of success (Popoc, *et al*., 2000, Popali *et al*., 2002, Gurses *et al*., 2003). However, no investigation has been made to optimize coagulant dose which depends highly on the extent of soluble colour contributing COD. The effectiveness of coagulant is an indicator of floc formation and settling characteristics.

The present investigation is carried using the Poly Aluminium Chloride (PAC) for chemical coagulation of four selective reactive dyes generally used for cotton yarn dyeing. The objective of the present investigation is to assess the amenability and response of chemical coagulation of four selective dyes using PAC as a coagulant.

MATERIALS AND METHODS

Coagulant

A commercial grade Poly Aluminium Chloride ($AlCl_3$ $6H_2O$) is used as coagulant with varying doses of 0.8 to 3.0g/L.

Reactive dyes

(i) Reactive Blue 41 (Structure: Phtalocyanine (MCT)) (ii) Reactive Blue 184 (Structure: Azoic (MFT)) (iii) Reactive Blue 204 (Structure: Oxazine (MFT)) and (iv) Reactive Blue 209 (Structure: Formazan (FCP)) are used as model dyes. These dyes are extensively used for cotton yarn dyeing. Dye solutions are prepared in distilled water to a strength of 300mg/L for each dye. The COD of all the dyes are estimated as per the standard procedures (APHA, 1995).

Experimental method

Coagulation studies were conducted in duplicate using Jar-test Apparatus with six beakers of one litre capacity. A 500ml. dye solutions were taken in each beaker and different doses of PAC solutions were added. The samples were stirred for one minute at 600 rpm followed by 15 minutes slow mixing of 25 to 30 rpm. The contents are then settled for two hours. At the end of two hours, the supernatant is with drawn, filtered and was used for COD analysis (APHA, 1995). All the experiments were conducted at room temperature of 27 ± 3^0C.

RESULTS AND DISCUSSIONS

The result of the COD analysis of the four dyes used in the experimental system is presented in Table-1. The results indicate that exertion of COD for different reactive dyes is highly varied depending upon the dye constituents such as phenol derivatives, organic acid and benzene derivatives. The results of the Poly Aluminium Chloride coagulation of various dyes are presented in Figures 1 to 4. The results indicate that the removal of COD for each dye is highly varied, indicating that the solubility of these dyes in water is quite different. The performance of COD removal by chemical coagulation depends upon the solubility of the dyes in water.

Table-1. COD of the experimental reactive dyes.

S. No.	Dye	**COD** ($g.o_2/g.$ of dye)
1.	Reactive Blue 41	1146
2.	Reactive Blue 184	842`
3.	Reactive Blue 204	652
4.	Reactive Blue 209	796

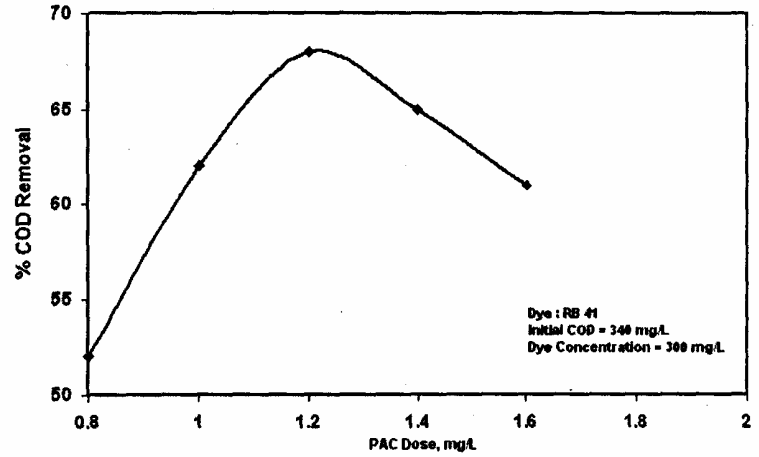

Fig . 1 Removal of COD by PAC at various doses

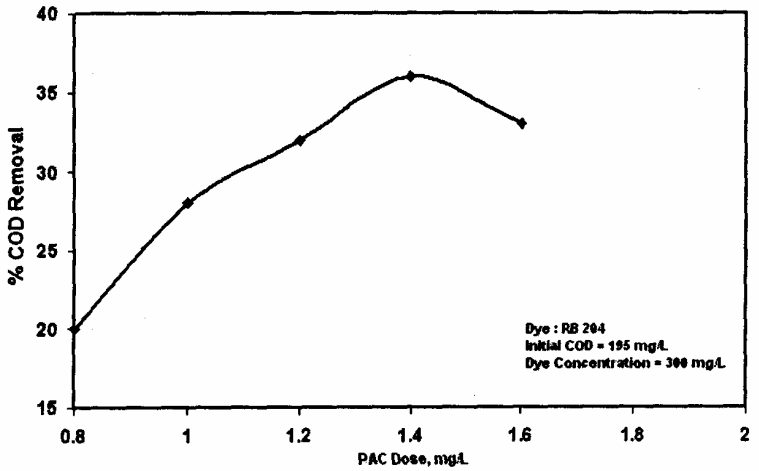

Fig .2 Removal of COD by PAC at various doses

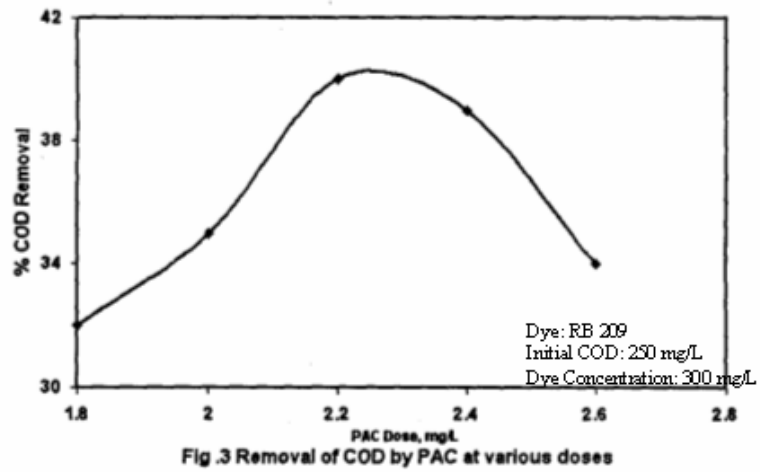

Fig .3 Removal of COD by PAC at various doses

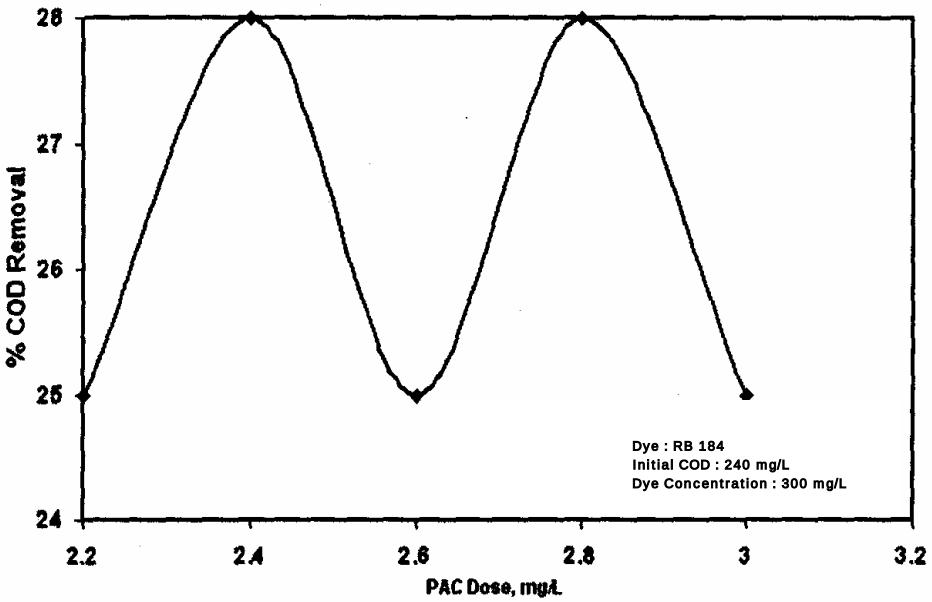

Fig .4 Removal of COD by PAC at various doses

The reactive dyes which are highly soluble in water can not be easily flocculated by coagulants (Al degs, *et al.*, 2000). This is quite evident in floc formation in the present investigation. The nature of floc formation for different doses of Poly Aluminium Chloride is shown in Table-2 and the optimum dose of Poly Aluminium Chloride and the percent removal of Chemical Oxygen Demand (COD) are given in the Table-3.

Table-2. Nature of floc formation for different doses of PAC.

S. No.	Dye	Dose of PAC (g/L)	Nature of floc
1.	RB 41	<0.4	No floc formation.
		0.4-0.8	Slightly visible flocs with little settlement.
		>2.0	Highly turbid flocs with little settlement.
2.	RB 184	<1.0	No floc formation.
		1.2-1.6	Slightly visible flocs with little settlement.
		>3.0	Highly turbid flocs with little settlement.
3.	RB 204	<0.4	No floc formation.
		0.4-0.8	Slightly visible flocs with no settlement.
		>2.0	Highly turbid flocs with little settlement.
4.	RB 209	<1.8	No floc formation.
		1.8-2.2	Slightly visible flocs with no settlement.
		>3.4	Highly turbid with no settlement.

Table-3. Optimum dose of PAC and percent removal of COD.

S. No.	Dye	Optimum dose mg. PAC/mg COD removed	% COD removal
1.	RB 41	5.2	68
2.	RB 209	34.3	40
3.	RB 204	20.0	36
4.	RB 184	22.0	29

CONCLUSIONS

Based on the present investigations, following conclusions can be drawn:

a) RB 41 is only the dye responded for moderate removal of COD. The other dyes responded as poor removals of COD;
b) The order of demand of PAC for unit removal of COD is - RB 209> RB 184>RB 204>RB 41;
c) The treated effluent with chemical coagulation by PAC needs further treatment to reduce COD; and
d) The result of the present investigation clearly demonstrates that when RB 184, RB204, and RB 209 present in dye waste water, chemical coagulation should not be attempted as a treatment measure by the dyeing units of the textile industry.

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