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Research Article

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Physico-chemical treatment of textile mill dye waste by coagulation & flocculation using alum with bentonite clay

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ABSTRACT

The main objective of the present study was treatment of dye waste by coagulation and flocculation with alum and clay to achieve maximum removal efficiency of color and COD. Textile mill dye waste was treated using Coagulant (Alum) with weighting agent (Bentonite clay). Wastewater samples were collected from Riba Textiles, Haryana, India. Wastewater was highly alkaline, high in suspended solids and color. The parameters of importance were color and Chemical oxygen demand (COD). Optimum coagulant dose and optimum pH were determined by Jar test. Coagulant dose coupled with clay dose were added to wastewater for better coagulation and flocculation to obtain maximum removal efficiency of color and COD. The results showed that physico-chemical method of coagulation & flocculation using alum with clay produced 92% COD removal and 68% color removal which was almost equivalent to what was achieved in the treatment plant in the industry using one stage physico- chemical and two stage biological treatment. This resulted in reducing the running cost of effluent treatment plant by simplifying the treatment scheme as well as saving costly coagulant to a great extent.

Keywords: Coagulant, Weighting agent, Coagulation, Flocculation.

INTRODUCTION

Textile industry is a major polluter of water bodies producing highly colored wastewater which is highly alkaline, high in suspended solids and COD. The volume of wastewater generated is also large. 235 litres of wastewater is generated per Kg. of cloth produced. The effluent wastewater mainly comprise of chemicals like hydrosulphite, sulphide and sulphur dyes causing rapid depletion of dissolved oxygen affecting aquatic life adversely. Wastewater from textile mills also contain carbonate, hydroxide, chloride, peroxide, sulphite, nitrite, silicate, oxychloride & sulphide of sodium, sulphuric acid , hydrogen peroxide, bleaching powder, starch and gum etc. A lot of research work has been undertaken, both in India & abroad in the field of treatment of textile industry wastewater by various techniques. The existing treatment methods of textile industrial effluents processing about 8^5 to 10^5 m of cotton & synthetic fibres appear to be inadequate to bring down the BOD, suspended solids, COD and other pollutants to meet the required effluent standards. Textile mill operations consist of weaving, dyeing, printing and finishing. Many processes involve several steps each contributing a particular type of waste. Numerov [6] gives the five techniques of treating textile dye waste before discharge into a stream which includes equalization, neutralization, proportioning, color removal and reduction of organic oxygen demanding matter. Chamberlain [4] reported that instead of coagulating dye wastes chemically, chlorine is used in the form of chlorinated copperas to oxidize or bleach many dyes and to remove BOD from sulphur dyes. Govindan & Sundarlingam [16] found that textile mill wastewater can be treated in admixture with sewage (1:5) by waste stabilization pond method. The BOD reduction was estimated to be as high as 98%. The treatment plant must be designed and planned after studying in detail of the wastewater characteristics and serious & exhaustive planning considering the reduction of the waste volume and strength through the process of chemical substitution, chemical & grease recovery and recycling of water. Caustic recovery from the kiering & mercerizing wastes using dializers reduces the pollution load to a great extent. The remaining pollution load of the waste is dealt with in operations like segregation, equalization, neutralization, chemical precipitation, chemical oxidation & biological oxidation.

EXPERIMENTAL SECTION

Wastewater samples were collected from Riba Textiles,Village Chidana, Tehsil Gohana, District Panipat, Haryana, India. The wastewater production from the industry was 300 m^3/day. The wastewater had a dark blue color imparted by the presence of various dyes used. The samples of wastewater were analysed for pH, alkalinity, COD, turbidity and color. The entire analysis was carried out according to "Standard methods for treatment of water & wastewater". In the present study, Jar test was conducted to find out the optimum coagulant dose. Supernatant was analysed and curves of dosage of alum v/s COD, alkalinity & % color removal were plotted. The point on the curve which gives lowest value of COD for a given dosage is the optimum coagulant dose. In the 2^{nd} step, Jar test was conducted to obtain optimum pH. During the 3^{rd} step, bentonite clay was used as a coagulant aid to increase the rate of formation of flocs in the jars. Clay was added from 0 to 100 mg/l with 20 mg/l variation in the six jars. During the 4^{th} step, clay was added in the same manner but from 0 to 50 mg/l. results of analysis of 3^{rd} & 4^{th} step were compared. This was done to find out the minimum coagulant dose that with the help of clay as a coagulant aid gives maximum efficiency of COD & color removal. For % color removal determination, wastewater samples were analysed on Spectronic 20 spectrophotometer. Absorbance was noted for different wavelengths and an absorbance v/s wavelength curve was plotted. This gave optimum wavelength for which absorbance is minimum. Now, various dilutions of the sample were prepared and their absorbances noted for the given optimum wavelength. A calibration curve was plotted between Absorbance V/S % dilution which directly gives % color removal. pH and alkalinity were determined with the help of pH meter and turbidity with the help of Nephlometric turbidity meter. COD was analysed as per standard methods closed reflux analytical technique.

RESULTS AND DISCUSSION

The efficiency of physico-chemical treatment was calculated in terms of COD reduction & color removal of samples collected before coagulant addition and after sedimentation. With 200 mg/l alum dose, COD removal was found to be 56.8% and color removal was 48%. COD and color removal were 80.1% & 36% for pH of 6.6 at coagulant dose of 200 mg/l. COD & color removal were 91.72% and 67.50% for pH 6.6, coagulant dose 100 mg/l and clay dose 100 mg/l. COD & color removal were 84.14% and 52.00% for pH 6.6, coagulant dose 50 mg/l and clay dose 100 mg/l. The composite wastewater has BOD & COD in the range between 180-220 mg/l and 400-500 mg/l respectively. With increase in the dose of clay in the flocculation experiment, coagulant produced rapid settling flocs and good clarifications were consistently obtained.

TABLE 1

S.NO.	WAVELENGTH(nm)	ABSORBANCE
1.	340	0.185
2.	360	0.160
3.	380	0.135
4.	400	0.125
5.	440	0.100
6.	480	0.100
7.	520	0.125
8.	560	0.130
9.	600	0.135

TABLE 2

S.NO.	% DILUTION	ABSORBANCE
1.	10	0.060
2.	20	0.050
3.	30	0.045
4.	40	0.040
5.	50	0.038
6.	60	0.035
7.	70	0.025
8.	80	0.020
9.	90	0.010

TABLE 3

S. NO.	Alum dose(mg/l)	pH	Turbidity(NTU)	Alkalinity as $CaCO_3$(mg/l)	COD(mg/l)	% COD removal	% Color removal
1.	0.0	7.75	2.0	650	384.0	4.0	0.0
2.	50.0	7.65	1.5	624	268.8	32.8	4.0
3.	100.0	7.50	1.0	596	192.0	52.0	26.5
4.	150.0	7.40	1.0	560	192.0	52.0	42.5
5.	200.0	7.30	0.0	516	172.8	56.0	48.0
6.	250.0	7.20	0.0	508	211.2	47.2	48.0

TABLE 4

AT OPTIMUM COAGULANT DOSE (200 mg/l)

S. NO.	Turbidity(NTU)	Adjusted pH	pH	Alkalinity(mg/l)	COD(mg/l)	% COD removal	% Color removal
1.	3.0	7.7	7.45	570	115.86	71.03	18
2.	3.0	7.1	7.00	490	112.55	71.86	27
3.	2.5	6.6	6.35	460	79.44	80.14	36
4.	3.8	6.4	6.25	360	115.86	71.03	28
5.	5.0	6.0	5.80	168	96.00	76.00	22
6.	5.0	5.5	5.35	96	112.55	71.86	08

TABLE 5

AT 100 mg/l COAGULANT DOSE, pH 6.6

S. NO.	Clay dose (mg/l)	Initial pH	Adjusted pH	Final pH	Alkalinity	Turbidity	COD(mg/l)	% COD removal	% Color removal
1.	0.0	7.8	6.6	6.35	460	3.0	99.31	75.17	18.0
2.	20.0	7.8	6.6	6.35	460	6.0	98.05	75.48	28.0
3.	40.0	7.8	6.6	6.35	460	9.0	96.00	76.00	40.0
4.	60.0	7.8	6.6	6.35	460	12.0	66.20	83.45	60.0
5.	80.0	7.8	6.6	6.35	460	15.5	66.20	83.45	59.0
6.	100.0	7.8	6.6	6.35	460	19.0	33.10	91.72	67.5

TABLE 6

AT 50 mg/l COAGULANT DOSE, pH 6.6

S. NO.	Clay dose (mg/l)	Initial pH	Adjusted pH	Final pH	Alkalinity	Turbidity	COD(mg/l)	% COD removal	% Color removal
1.	0.0	7.8	6.6	6.45	540	3.5	110.45	72.38	11.0
2.	20.0	7.8	6.6	6.45	540	6.5	106.42	73.39	21.0
3.	40.0	7.8	6.6	6.45	540	10.0	102.25	74.43	32.0
4.	60.0	7.8	6.6	6.45	540	13.5	92.67	76.83	48.0
5.	80.0	7.8	6.6	6.45	540	16.0	91.53	77.11	46.0
6.	100.0	7.8	6.6	6.45	540	19.5	63.42	84.14	52.0

CONCLUSION

The following conclusions and recommendations were drawn:

1. The wastewater consists of low strength waste stream with COD concentration of about 400 mg/l.

2. The average BOD_5/COD ratio of wastewater is 0.425, which is lower than the accepted value for biodegradable wastes (0.5).
3. Optimum wavelength for minimum absorbance for the wastewater sample is 460 nm.
4. Optimum coagulant dose is 200 mg/l.
5. Optimum pH of wastewater for coagulation process is 6.6 .
6. For a particular dose of coagulant, effective coagulation was found to be pH dependent.
7. Addition of clay in the flocculation system increases the turbidity of the waste water sample, as it has a very low turbidity, thus increasing the efficiency of floc formation & settling.
8. The aim of the study was to effectively reduce the coagulant dose with maximum removal efficiencies of COD & color. Since, maximum COD removal at 100 mg/l coagulant dose with 100 mg/l clay dose is nearly same as the COD removal in the effluent treatment plant, it is recommended that the coagulation/flocculation must be done at pH 6.6 with 100mg/l alum & clay dose.

REFERENCES

[1] AG Bhole; SM Dhabadgaonkar; *IAWPC Tech. Annual*, 14, **1987**, 52-56.
[2] AK Mittal; I Mehrotra; *Indian J. Environ. Health*, Vol. 23, No.3, **1981**, 203-214.
[3] AV Rao; BL Jain; IC Gupta; *Indian J. Environ. Health*, Vol. 35, No.2, **1993**, 132-138.
[4] CMA Ademoroti; *Effluent and water treatment Journal*, **1980**, 541-549.
[5] CW Yeun; ASCE, *Journal of Environ. Engg. Division*, **1974**, 541-548.
[6] D Benefield; JF Judkins; BL Weand; “Process chemistry for water and wastewater treatment”, Prentice Hall NJ 7632, **1982**.
[7] JD Haff; JK Edzwald; JW Boak; ASCE, *Journal of Environ. Engg. Division*, **1977**, 989-1000.
[8] KK Jain; Likun; RR Rothfus; ASCE, *Journal of Environ. Engg. Division*, **1973**, Vol.99, 4-11.
[9] Kothandraman et. Al., *Indian J. Environ. Health*, Vol. 18, 1976 ,99.
[10] Minimal national standards for dye & dye industries: COINDS/34/**1990**.
[11] NEERI, “Treatment of textile mill wastes”, Internal report; **1971**, 1972, 1973, 1980.
[12] RF Packham; “Theory of coagulation process-A survey of literature”, Proc. of soc. for water treatment and examination, Vol. 11, **1962**, 106.
[13] RF Packham; *Journal of applied chemistry*, Vol. 12, **1962**, 564.
[14] RJ Thronton; FC Blanc; ASCE, *Journal of Environ. Engg. Division*, **1973**, 535-544.
[15] “Standard methods for the examination of water and wastewater”, 16th edition, APHA, AWWA, WPCF, **1985**.
[16] VS Govindan; VS Sundarlingam; *Indian J. Environ. Health*, Vol. 21, **1979**, 321-331.