Jr. of Industrial Pollution Control 23 (1)(2007) pp 125-130

SEQUENTIAL COAGULATION STUDIES FOR PRIMARY TREATMENT OF TEXTILE PROCESS EFFLUENT INSTEAD OF ACID NEUTRALIZATION

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Key words : Ttextile effluent, Sequential coagulation.

ABSTRACT

Sequential coagulation studies were carried out for primary treatment of textile effluent from different processing units at Ichalkaranji by using jar test apparatus. Various combinations of Alum, Ferric chloride and Lime, were used for the studies. It has been observed that of all the pH values, maximum (65-90%) reduction in COD, (80 to 85%) in colour and TDS removal upto (30-40%) of the actual process effluent is possible to achieve. As far as heavy metal(s) removal is concerned at the said pH, it can be seen that the maximum removal of Ni and Pb upto approx. 99% was observed. Findings of other heavy metals removal, i.e. Cd (96%), Cr (total) (80-90%), Cu (90%), Zn (80 to 90%) and Fe (80%) was observed in various combinations of Alum, Ferric chlorine and Lime, for primary treatment. Such primarily treated textile effluent can be easily treated by biological means.

INTRODUCTION

With the ecology being the password of the world today, the country has to focus on environment friendly products and production processes. The textile industry is one of the oldest and second largest industry next to agriculture providing bread & butter to over 20 million people. About 700 textile mills are located mainly at Ahmedabad, Mumbai, Coimbatore, Delhi, Kanpur, Ludhiana and Ichalkaranji. It is one of the leading foreign exchange earners through export of textiles. Therefore, it has to focus its attention on production of environmental friendly textiles and effluent treatment.

Textile industry can be broadly classified in to spinning, weaving, processing and garmenting. The spinning, weaving and garmenting are the dry processes and do not contribute to water pollution. However, it is the wet processing which contributes significantly to water pollution. The pollutants generated mainly from processing of cloth, which consists of desizing, scouring, bleaching, mercerising, dyeing, printing and finishing operations. The wool processing consists of scouring, stock-dying, carding, fulling, washing, carbonising, dyeing, bleaching, and brightening. Such processing operation involves the use of more than 8000 chemicals e.g. acid, alkali, oil, detergents,dyes,SO_2,H_2O_2 etc. and they generate pollutants which ultimately meet the receiving water bodies reflecting in terms of pH, colour, dissolved solids, suspended solids, acidity or alkalinity, BOD, COD, phenolics, chlorides, oil and grease, sulphate and sodium etc. Some chemicals such as dyes, detergents, etc. needs extra care for proper treatment and disposal of the textile process effluent. Recent research and surveys indicate large quantity of water for specific processes. About 230 lt. of water is required for processing 1 Kg. of fabric. While similar other investigations indicate that the unit consumes 360 ltr. Of water / kg of cloth. With the advancement of ecofriendly processing the water requirement has been brought down to about 150 L/kg for 100% cotton fabrics and about 90 lt. for 100 % polyester fabrics. Summarily, it can be seen that there is no definite figure for water consumption in the textile mills and it varies from mill to mill and one process to other. However, mills having complex processes may consume more water. So an average mill producing 60,000 meter of fabrics/day is likely to discharge approximately 1.5 million lt/day, of effluent and out of the total water consumed in the textile mills, around 38 % is used for bleaching, 16 % for dyeing, 8 % for printing, 14 % for boilers and 24 % for miscellaneous uses. On an average an independent textile process, processing polyesters/cotton woven goods discharges about 2 to 6 lakh of liters of effluent per day depending upon the production, process employed and the type of machinery used. Thus for the processing of one kg. of 100 % cotton fabrics about 125 liters of effluent is generated where as during the processing of 100 % polyester fabrics about 65 to 70 liters of effluent is generated.

The composition of textile mill effluent is complex and fluctuating in nature. The characteristics of effluent depends on the nature of the textile products and the raw-materials used. It has normally high pH and dissolved solids and persistent chemicals such as dyes, dye - intermediates and detergents etc. Conventional treatment can remove the pollution load to a considerable extent. However, such type of treatment can not ensure complete treatment of such effluents in all cases. It needs special attention for pre-treatments. One such investigations has been conducted in KIT laboratories for the treatment of

Table 1

Analysis of textile process effluent from different streams

No. Characteristics	Desizing	Kiering	Bleaching	Mercerising	Dyeing	Printing
1. pH	8.6 to 10	10.9 to 11.8	8.4 to 10.9	8.1 to 9.8	9.2 to 11	6.7 to 8.2
2. Alkalinity, mg/L	490 to 2480	4780 to 19000	2780 to 6280	930 to 1005	1250 to 3160	500 to 1080
3. Total Solids, mg./L	7870 to 8290	14220 to 40580	2980 to 8240	2220 to 3030	3600 to 6540	2110 to 2750
4. Total Dissolved Solids mg./L.	5580 to 6250	12260 to 38500	2780 to 7900	2060 to 2600	3230 to 6180	1870 to
2360 5.	Suspended Solids mg./L		2290 to 2670	1960 to 2080	200 to 300	160 to 430
360 to 370	250 to 390	6.	B.O.D. (5 days at $20^{\circ}C$) mg/L		1000 to 1080	2500 to 3480
87.5 to 535	100 to 1222	130 to 820	135 to 1380	7.	C.O.D.mg./L	1650 to 1750
12800 to 19600	1350 to 1575	246 to 381	465 to 1400	410 to 4270		

alkaline textile process effluent. Coagulants such as lime, ferric chloride and alum were used for the sequential coagulation followed by biological treatment.

MATERIALS AND METHODS

Sample Collection

Samples were collected in grab, composite mode, preserved and transported to laboratory for various experiments as well as for analysis.

METHODOLOGY

For coagulant system jar test apparatus study was performed for primary treatment of textile process effluent by various coagulants and for their treatment efficiencies. Freshly prepared coagulants viz. alum, ferric chloride and lime water with known dosing were used for 60 seconds mixing time. After complete mixing, one hour settling time was allowed for each set.

RESULTS AND DISCUSSION

It has been observed that at all the pH values, maximum (65-90%) reduction in COD, (80 to 85%) in colour and TDS removal upto (30-40%) of the actual process effluent is possible to achieve. As far as heavy metal(s) removal is concerned at the said pH, it can be seen that the maximum removal of Ni and Pb upto approx. 99% was observed. Findings of other heavy metals removal, i.e. Cd (96%) Cr (total) (80-90%), Cu (90%), Zn (80 to 90%) and Fe (80%) was observed in various combinations of Alum, Ferric chloride and Lime, for primary treatment.

CONCLUSION

It can be concluded that sequential coagulation is helpful in removal of primary pollutants to considerable extent. Such primarily treatment textile effluent can be easily treated

Table 2
Chemical analysis of combined textile process effluent.

No.	Characteristics	Range
1.	pH	6.7 to 11.8
2.	Total Alkalinity (as $CaCo_3$) mg/L	296 to 1098
3.	Total Dissolved Solids mg/L	1200 to 4438
4.	Suspended Solids, mg/L	80 to 1732
5.	B.O.D. (5 days at 20°C) mg/L	65 to 760
6.	C.O.D. mg/L	358 to 1418
7.	Chlorides mg./L	350 to 1390
8.	Sulphates mg/L	70 to 600

Table 3
Combination of various coagulants used for the treatment of textile effluent from different processes of Ichalkaranji.

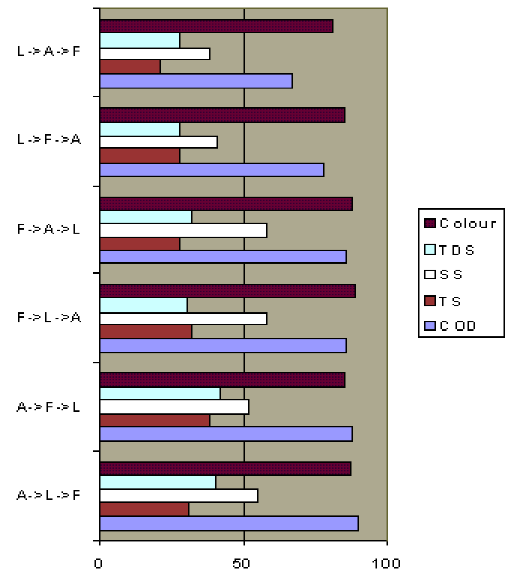
Sr. No.	Combination
1.	Alum → lime → ferric chloride (ALF)
2.	Alum → ferric chloride → lime (AFL)
3.	Ferric chloride →lime → alum (FLA)
4.	Ferric chloride → alum → lime (FAL)
5.	Lime → ferric chloride → alum (LFA)
6.	Lime → alum → ferric chloride (LAF)

Table 4
Overall performance of sequential coagulation at various pH values for reduction in chemical characteristics

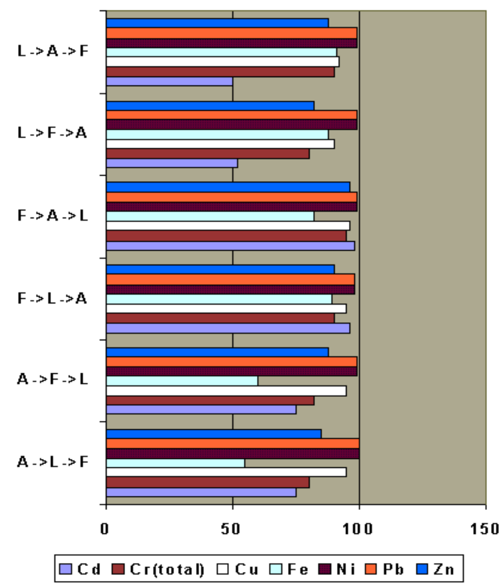
Coagulant System	Overall performance (%) at pH				
	6.0	7.0	8.0	9.0	10.0
ALF	63	62	63	61	61
AFL	62	65	64	64	62
FLA	57	61	56	62	61
FAL	56	60	61	64	60
LFA	61	57	61	53	52
LAF	59	58	60	54	49

Table 5
Overall performance of sequential coagulation at various heavy metals values for reduction in chemical characteristics

Coagulant System	Overall performance (%) at pH				
	6.0	7.0	8.0	9.0	10.0
ALF	71	71	72	76	75
AFL	82	80	81	86	86
FLA	87	93	91	96	96
FAL	91	91	90	96	97
LFA	88	78	88	89	85
LAF	84	74	88	90	86



Graph 1 Percent Removal in chemical characteristics in sequential coagulation at pH 10, A-Alum, F-Ferric Chloride, L-Lime



Graph 2. Percent reduction of heavy metals in Sequential Coagulation System at pH 10, A-Alum, F-Ferric Chloride, L-Lime

by biological means.

ACKNOWLEDGEMENT

Authors are grateful to the Principal, KIT College of Engineering, Kolhapur, the Principal, DKTE's Textile and Engg. Institute, Ichalkaranji, Head CFC, Shivaji University, Kolhapur and the Head, Department of Biotechnology, KIT's College of Engg., Kolhapur for providing facilities and encouragement throughout the studies.

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