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Treatability Study of Tannery Effluent by Enhanced Primary Treatment

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Abstract: *This project work has been focused on the study of enhanced primary treatment of tannery effluent by coagulants which includes analysis of physico-chemical parameters of tannery effluent as well as the treatment efficiency of alum, ferric sulphate and their combination (alum + ferric sulphate). Sample collection and analysis were performed using standard methods for the examination of water and wastewater (1998). Tannery effluent has been treated with the coagulants. The influences of pH and coagulant dosages were studied. Conditions were optimized according to the pollutant removal efficiencies measured in terms of reduction in concentration of total suspended solid (TSS), biological oxygen demand (BOD5), chemical oxygen demand (COD) and Chromium(Cr). The reduced concentration of pollutants have been analyzed with industrial effluent discharge standards to determine the efficiency of coagulants in enhanced primary treatment of tannery effluent.*

Keywords: *alum, ferric sulphate, total suspended solid (TSS), biological oxygen demand (BOD5), chemical oxygen demand (COD) and chromium (Cr)*

I. Introduction

Industrial wastes are usually generated from different industrial processes, as a result the amount and toxicity of waste released from industrial activities varies with the industrial processes. Again, among all the industrial wastes tannery effluents are ranked as the highest pollutants (Shen, 1999). In developing countries, many industrial units are operating in a small and medium scale. These industrial units can generate a considerable pollution load by discharging untreated effluents directly into the environment.

Over the last few decades large scale usage of chemicals in various human activities has grown very fast, particularly in a country like India which has to go for rapid industrialization in order to sustain over growing large problem of population.

The current pattern of industrial activity alters the natural flow of materials and introduces novel chemicals into the environment. The released organic compounds and heavy metals are one of the key factors that exert negative influences on man and environment causing toxicity to plants and other forms of biotics and abiotics that are continually exposed to potentially toxic heavy metals.

But in recent years, the concentrated growth of this industry in certain localities has shown how the waste from this industry can cause irreversible damage to the water environment in the vicinity. In view of its peculiar pollution potential, and the increasing demand for good quality of water, both for domestic and other industrial purposes, it has become essential to treat the waste to a certain degree prior to its disposal. Tanning industry contributes significantly towards exports, employment generation and occupies an important role in Indian economy on the other hand, tannery wastes are ranked as the highest pollutants among all the industrial wastes. The damage to the environment by the hazardous tannery effluent is becoming an acute problem in the country.

The chrome tanning process results in toxic metals, especially chromium passing to wastewater and are not easily eliminated by ordinary treatment process. Tannery effluents are mainly characterized by high salinity, high organic loading and specific pollutants such as chromium. Various chemicals used in tanning are lime, sodium carbonate, sodium bi-carbonate, common salt, sodium sulphate, chrome sulphate, fat liquors, vegetable oils and dyes. The tannery effluent was found to contain higher concentrations of total dissolved solids, chromium, chloride, ammonia, nitrate and sulphates when the samples were collected from the outlets of the industry. Besides these, chemicals such as zinc chloride, mercuric chloride and formaldehyde are used as disinfectants, sodium chloride in curing and as bleaching powder and sodium fluoride to prevent putrefaction, lime in liming, sodium sulphate, ammonium chloride, borax and hydrochloric acid in deliming, sodium for decreasing and basic or acidic dyes in leather finishing.

Hence, the tannery effluent is always characterized by its strong colour (reddish dull brown), high BOD, high pH, and high dissolved solids. The other major chemical constituents of the waste from the tanning industry are sulphide and chromium. These chemicals mixed with water are discharged from the tanneries and pollute the ground water permanently and make it unfit for drinking, irrigation and general consumption. Therefore there lies an urgent need to determine the pollution levels in the effluent from these industries.

Treatment of tannery effluent is difficult and represents a serious environmental and technological problem due to presence of a series of chemicals with low biodegradability. So the treatment of tannery effluents is a matter of great concern in the country having leather tanning industry. As a result, a number of research work carried out around the world regarding the treatment of tannery effluents using different technology. Several studies have been carried out for the treatment of industrial effluents through coagulation and flocculation process (Shouli et al., 1992).

II. Materials and methods

2.1 Sampling

For the present investigation, the sample was collected at the discharge drain to sedimentation tank of Forward Leathers, Nagalkeni, Chromepet, Chennai.Tannery effluent was collected into plastic bottles which were thoroughly cleaned with nitric acid solution followed by repeated washing with distilled water and dried. After collection, physical appearance and pH were noted and preserved at 4^0C. All the pollutant parameters were analyzed following the procedure as per the Standards Methods for the Examination of Water and Wastewater (APHA-AWWA-WPCF, 1998).

2.2 Analysis of physico-chemical parameters

All the pollutant parameters were analyzed following the procedure as per the Standards Methods for the Examination of Water and Wastewater (APHA-AWWA-WPCF, 1998) which is shown in table 2.1.

Table 2.1. Analysis of physico-chemical parameters

S.No.	Parameter	Method of analysis used
1	pH	pH meter
2	Turbidity	Digital Nephlometer
3	Total solids	Gravimetric Method
4	Total dissolved solids	Gravimetric Method
5	Total suspended solids	Gravimetric Method
6	Chlorides	Colorimetric Method
7	Biological oxygen demand	Microbiological Titration Method
8	Chemical oxygen demand	Closed Reflux Colorimetric Method
9	Chromium	Colorimetric Method
10	Weight	High precision balance

2.3 Physical and Chemical parameters of tannery effluent

Physical and chemical parameters of collected tannery effluent were analyzed by the method of analysis shown in table 2.1. And the observed values were tabulated in table 2.2.

Table 2.2 Physical and chemical parameters of tannery effluent

Parameter	Values
Appearance	Brownish
Odor	Objectionable
pH	6.2
Turbidity	207.5 NTU
Total solids	7500 mg/l
Total suspended solids	2550 mg/l
Total dissolved solids	4950 mg/l
Chlorides	1136 mg/l
BOD_5	3480 mg/l
COD	5479 mg/l
Chromium	67 mg/l

2.4 Primary treatment by chemical coagulation

Coagulation is the process by which colloidal particles and very fine solid suspensions initially present in a wastewater are combined into larger agglomerates that can be separated via sedimentation, flocculation, filtration, centrifugation or other separation methods. Coagulation is commonly achieved by adding different types of chemicals (coagulants) to the wastewater to promote destabilization of the colloid dispersion and agglomeration of the resulting individual colloidal particles.

The addition of some common coagulants to a wastewater not only produces coagulation of colloids but also typically results in the precipitation of soluble compounds that can be present in the wastewater. In addition, coagulation can also produce the removal of particles larger than colloidal particles due to the entrapment of such particles in the flocs formed during coagulation.

2.5 Coagulants used

The coagulants alum, ferric sulphate and combination of alum and ferric sulphate were used for the experiment. Each of this coagulant weighed individually (15 g) and dissolved in the 1 litre of distilled water.

After rigorous mixing, different doses (20 to 110 mg/l) of coagulant solution were taken to treat 1 litre of tannery effluent. Mixed coagulants were added at the same time and at the same ratio.

The jar test is the most widely used method for evaluating and optimizing the flocculation process. This study consists of rapid mixing, slow mixing and sedimentation. The apparatus consists of four beakers to be agitated

simultaneously. Tannery effluent with coagulants are agitated in a flocculator at 100 rpm for 1 minute and then 30 rpm was quickly established for 10 mins.After slow mixing beakers were removed carefully from the flocculator and allowed to settle for 60 minster clear effluent from few mm below level of water was taken out for analysis.

III. Results and discussion

The Jar Test was done with coagulants. The amount of residual pollutant in effluent is measured at the end of each pH experiment (keeping dosage of coagulant constant) and optimum pH is fixed by observing maximum removal of pollutants and with that optimum pH, dosage were varied.

The optimum coagulation pH for alum is obtained by observing maximum percentage of pollutant removal which has been shown in Table 3.1 and figure 3.1.

Table 3.1. Optimum pH for alum

pH	% of removal rate of TSS	% of removal rate of BOD5	% of removal rate of COD	% of removal rate of Chromium
2	42	25	22	34
4	60	36	33	41
6	65	52	49	59
8	76	67	55	77
10	74	64	53	65
12	73	60	52	64

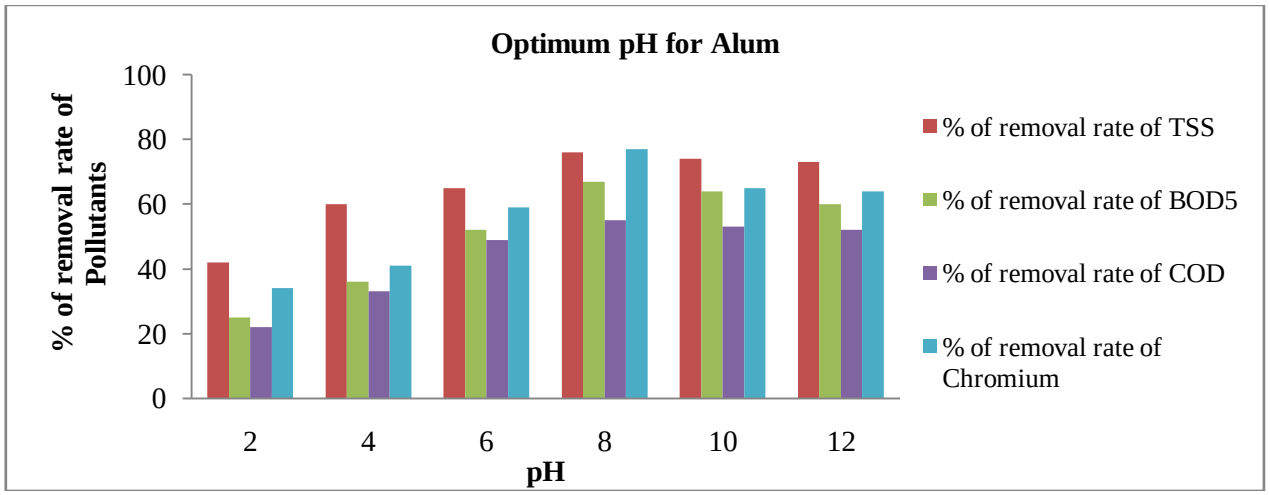

Figure 3.1. Optimum pH for Alum

The efficiency of the coagulants is clearly depicted by comparing the percentage of removal rate of pollutants from tannery effluent which has been shown in table 3.2 and figure 3.2.

Table 3.2. Comparison of % of removal rate of Total Suspended Solids (TSS) by coagulants

Dosage (mg/l)	Removal rate % of TSS of treated tannery effluent using Alum	Removal rate % of TSS of treated tannery effluent using Ferric sulphate	Removal rate % of TSS of treated tannery effluent using (Alum + Ferric sulphate)
20	15	12	28
30	28	25	44
40	32	30	55
50	39	37	62
60	49	47	80
70	76	69	95
80	91	86	95
90	89	87	93
100	88	87	92
110	87	87	88

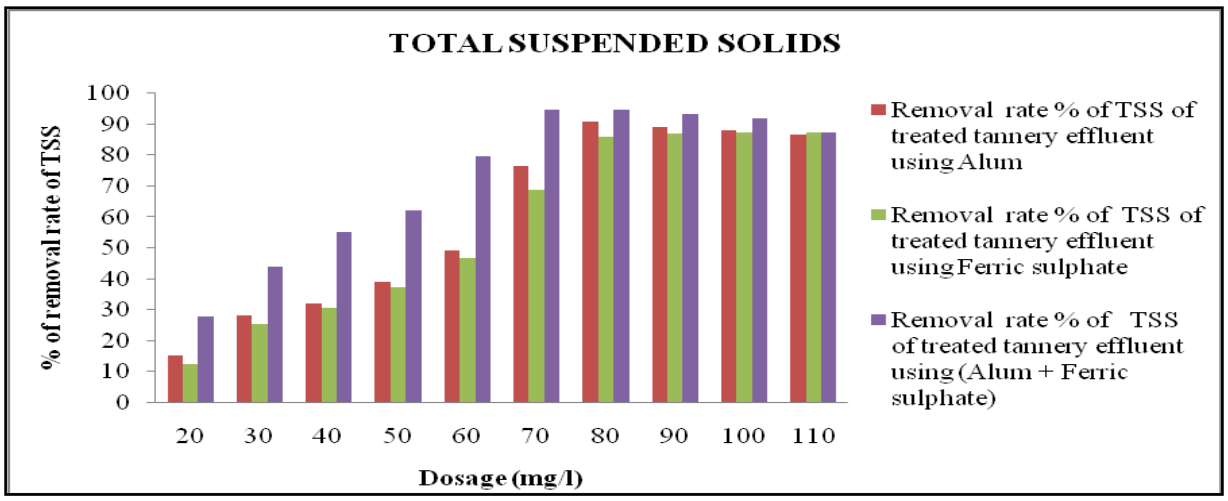

Figure 3.2. Comparison of % of removal rate of TSS by coagulants

IV. Conclusion

The study of tannery effluent by enhanced primary treatment has been carried out. After treatment with coagulants, the concentrations of pollutants were analyzed with industrial effluent discharge standards. From this study following conclusion has been made.

- The coagulants are effective for the treatment of tannery effluents.
- It is observed that pH8 is optimal for better efficiency of alum, ferric sulphate and their combination (alum ferric sulphate) for treatment of the tannery effluent taken for study.
- For alum dosage of 80 mg/l, 91% of TSS, 89% of BOD5, 78% of COD and 90% of Cr has been removed.
- For ferric sulphate dosage of 100 mg/l, 87% of TSS, 82% of BOD5, 71% of COD and 78% of Cr has been removed.
- For alum + ferric sulphate dosage of 70 mg/l, 95% of TSS, 91% of BOD5, 80% of COD and 92% of Cr has been removed.
- At optimum dosage, enhanced primary treatment with alum+ferric sulphate combination is effective for reduction of concentration of pollutants.
- National effluent discharge standards for total suspended solids, biological oxygen demand and chromium were met after enhanced primary treatment. However, COD content was high, emphasizing the need of secondary treatment for the tannery effluent.

Hence, from this study it has been concluded that alum+ferric sulphate coagulant combination is effective for reduction of concentration of pollutants from tannery effluent.

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