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Performance evaluation of the common effluent treatment plant and treatability study for the optimization of chemical dosing

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ABSTRACT

The present study was based on performance evaluation of Common Effluent Treatment Plant (CETP) and optimization of chemical dosing in the plant. Flow based composite samples were collected from collection tank, primary clarifier, secondary clarifier, aeration tank and final treated water. Testing was required to obtain the following necessary design and operating parameters pH, chemical oxygen demand (COD), total dissolved solid (TDS), total suspended solids (TSS), settling time (Min.) sludge generation (Volume). Total volume of sample was to monitor the treatment efficiency at different stages of treatment plant. Collected samples were analyzed in the laboratory. Water quality was determined after treating the wastewater with combination of physicochemical treatment.The study of the coagulation-flocculation process using various commercially available coagulants such as lime, ferrous sulphate and alum.Optimization pH and chemical concentration in the jar-tests. Performance and optimization of chemical dosing, doing trials with lime & $FeSO_4$ on the inlet water. Experiments were performed to replace $FeSO_4$ with alum. Treatibility study using lime with alum gave maximum reduction in COD, color with minimum sludge generation, as compared with $FeSO_4$. From the experiments it was observed that optimized dose of lime should be increased to 8 - 12 mg/l and the existing dosing of alum 60 - 85 mg/l to ensure proper removal of the suspended solids. Cost estimation was done, of the above coagulants after evaluating their performance.

KEYWORDS

pH;
COD;
TDS;
TSS;
Settling time;
Lime;
Ferrous sulphate and alum.

INTRODUCTION

Use of water for industrial proposes has increased significantly with rapid industrialization in the country[1,2]. The huge quantity of industrial wastewater generation process threat to quality of surface as well as groundwater[3]. Water can change physical, chemical and biological characteristic in such an extend that it is neither use for drinking nor use for other activities[4,5]. The treatment process may be physical, chemical and biological method and advanced treatment. Common effluent treatment plants are based on the concept of collection

of effluent of different industries having different characteristics treatment[1-6]. The permissible standard for various parameters are to be ensure by the industry before sending the effluent to the CETP. Performance evaluation can help in continual improvement in performances of CETP.

AIMS & OBJECTIVES

Performance

The performance evaluation study of the CETP was taken up with following objectives:

- To review the existing operational practice
- To monitor the performance of the different units of the CETP
- To assess the over all performance of the CETP.

Optimization of chemical dosing

The objectives of this work were as follows:

- Study of coagulation-flocculation process using various commercially available coagulants such as lime, ferrous sulphate and alum
- Optimization of pH and chemical concentration in the jar-tests
- Performance evaluation of the various coagulants
- Doing trials with lime & $FeSO_4$
- Also doing experiments with alum to replace $FeSO_4$
- Comparative study of the coagulants and determining the most suitable coagulants
- Cost analysis of the above coagulants after evaluating their performance.

MATERIAL AND METHODS

Chemicals: The work based on treatability studies by physicochemical method has been investigated for the different industrial waste. The following chemicals (using Lime, Ferrous Sulphate and Alum) were used as coagulants and jar test performed.

Treatability testing: The study was carried out in three steps. The first step consisted of the characterization of the wastewater samples[6-8]. The analyzed parameters were the pH, total solids, COD and turbidity. In the second step a physicochemical treatment was applied to wastewater in order to reduce COD and turbidity. Treatibility testing was required to obtain the following necessary design and operating parameters:

- Optimum pH levels for maximum removal of target metals.
- Chemical reagent dosage rates and application points.
- Settling rates.
- Sludge volume.

Jar testing: Jar testing is commonly used reliable and most effective coagulant or coagulant aid, as well as respective optimum dosage rates[6-12]. The objective of the test was simply to simulate the plant-scale coagulation and flocculation processes. Prior to full-scale plant trials, the technique used to determine the optimum dosage of coagulants was the jar test. Jar apparatus consists of graduated beakers with electrically operated stirrer whose speed can be controlled. Step-by-step jar testing procedures is used to maintain optimum pH, as well as for determining optimum coagulant and coagulant aid dosages. Samples of the supernatant were collected for subsequent analysis. For jar test analysis, a series of jars or beakers containing pH-adjusted influent samples were lined up beneath a series of mixers. To each jar was added simultaneously either different coagulants with the same dosage, or a different dosage of the same coagulant. 1000 ml of sample was placed in each beaker. Since many of the waste streams are acidic, it was necessary to adjust the pH to optimum, prior to the initiation of treatment. After flocculation, the samples were removed from the Jar test apparatus and allowed to settle for half an hour.

RESULTS AND DISCUSSION

Unit wise effluent treatment performance

The analysis results were depicted in the stage- wise performance of the CETP is shown in schematic diagram (Figure 1), with stepwise effluent quality.

The effluent receiving to the CETP was non-biodegradable. The effluent receiving to the CETP has pH 8.77 and after chemical dosing in primary clarifier pH was 7.36 and pH at secondary clarifier was 7.44. Final treated water has pH 7.59. The TDS concentration at inlet to CETP was very high i.e. 2690 mg/l which may be due to high chloride & dye-intermediates industries, these were over the influent parameter limit. After dosing TDS decrease, in primary & secondary clarifier from

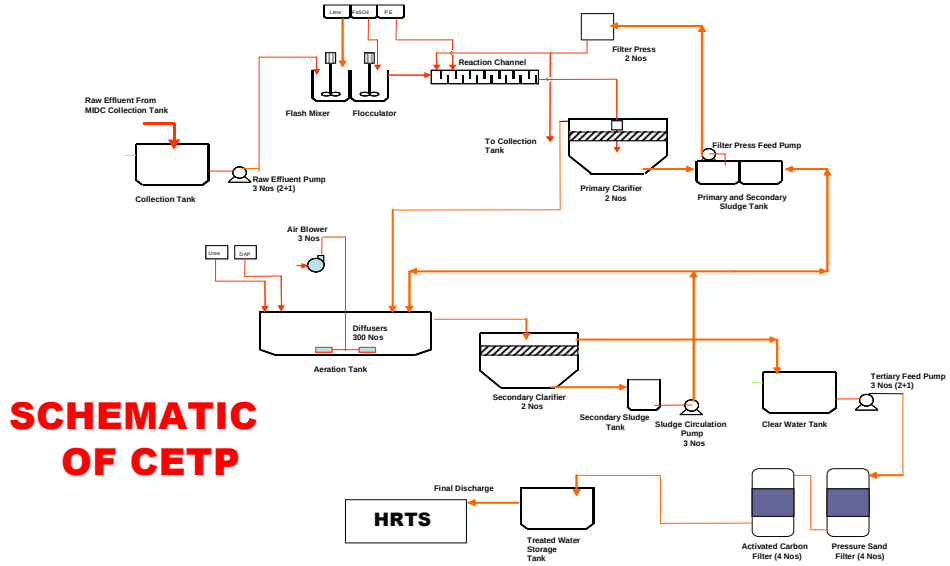

Figure 1 : Flow chart of CETP

2430 to 2210 mg/l and maintain with 1970 mg/l. The TSS concentration at inlet was 218 mg/l. The decrease in suspended solids concentration from alternatives each unit 164 mg/l & 114mg/l.to maintained 58 mg/l. The COD concentration at inlet of primary & secondary clarifier and final treat water was 878 mg/l, 672 mg/l, 258 mg/l and 196 mg/l respectively. The BOD concentration was similarly 340 mg/l, 228 mg/l, 36 mg/l and 23 mg/l respectively. The removal efficiency of BOD, COD, TSS and TDS was hardly to be 32.3%, 77.6%, 73.3% and 26.7% respectively. The analysis parameters and data's were depicted in the stage- wise performance in graphically mentioned in Figure 2 even after mixing the final treated effluent. This clearly show that problem create in treatment when industrial units were not providing the desired primary treatment to their effluent before sending to CETP.

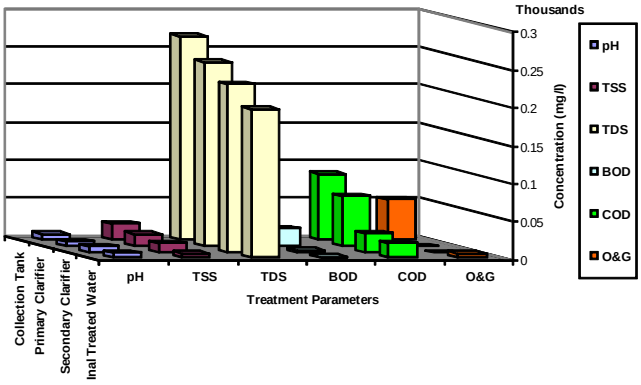

Figure 2 : Unit wise effluent treatment performance*
***Note: (TSS, TDS, BOD COD) x10**

Optimization of chemical dosing

Lime with ferrous sulphate

The performance of various type of coagulant for de-colorization of wastewater was investigated in the study. Various commercially available coagulants such as tries to be lime with ferrous sulphate and alum only. The results of the study have shown that all coagulants except lime with $FeSO_4$ individually and in combination can remove colour from moderate to high degree of dose. The analysis results of treatibility study using lime & ferrous sulfate were shown in Figure 3. Treatibility study using maintained pH of 9.5, 10.0, 10.5, 11.0 for average lime dosing of 9.0 mg/l, 18.0 mg/l, 27.0 mg/l and 55.0 mg/l, $FeSO_4$ consumed was, 67.0 mg/l, 90.0 mg/l, 102.0 mg/l and 233.0 mg/l.

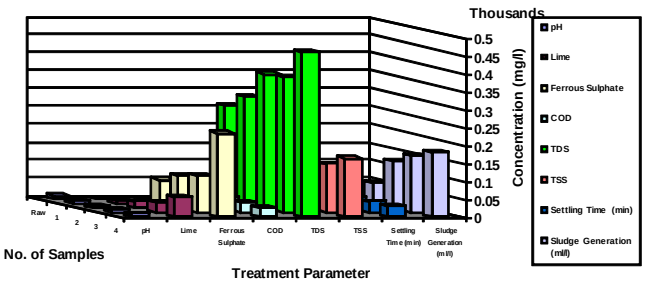

Figure 3 : Treatability study using lime & ferrous sulfate*

The corresponding sludge volume recorded after 30 min. was found to increase with increasing dose. The pH of the sample gradually decreases on increasing usage of $FeSO_4$ dose. COD was maintained but it settles higher quantity of sludge volume and do not prop-

erly removal color resulting in increased turbidity. The optimum dose was found in 13 - 20 mg/l of Lime with 75-85 mg/l of $FeSO_4$.

Lime with alum

Prior to the addition of alum as a coagulant, pH of wastewater was adjusted in optimum range with lime and then Treatibility was studied.

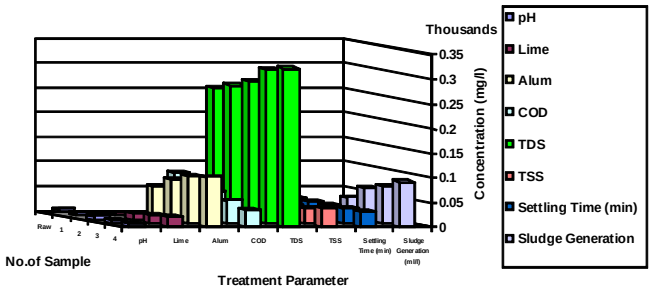

Figure 4 : Treatability study using lime & alum*

The analysis results treatibility study using lime & alum were shown in the form of graphically in Figure 4. The results of the study have shown that all coagulants, except lime with alum individually and in combination, can highly remove color from moderate to high degree of dose. Treatibility study using alum was done in the maintained pH range 7.5, 8.5, 9.5 and 10.5 for 8.0 mg/l, 12.0 mg/l, 17.0 mg/l and 19.0 mg/l of lime respec-

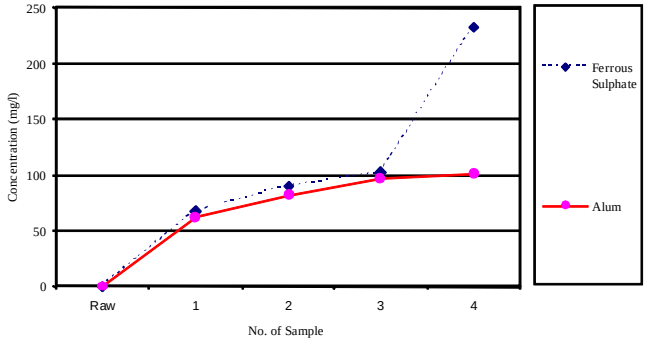

Figure 5 : Comparison with chemical dose

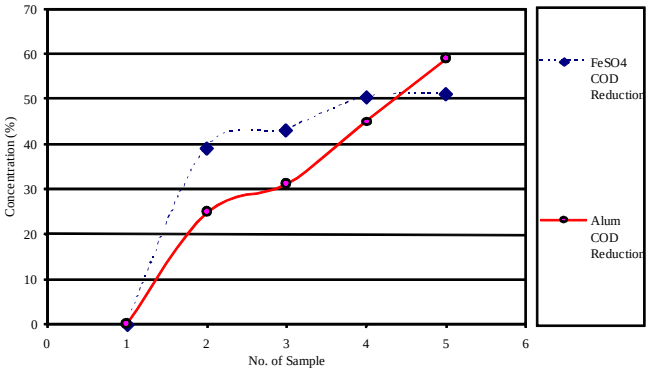

Figure 6 : Comparison with COD reduction

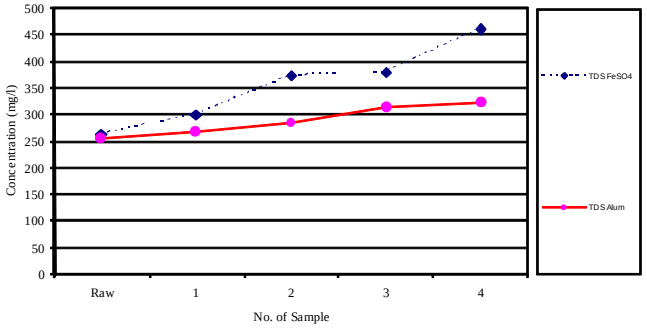

Figure 7 : Comparison with TDS reduction

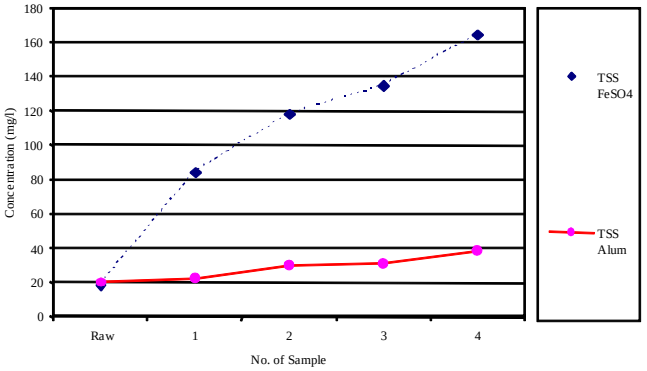

Figure 8 : Comparison with TSS reduction

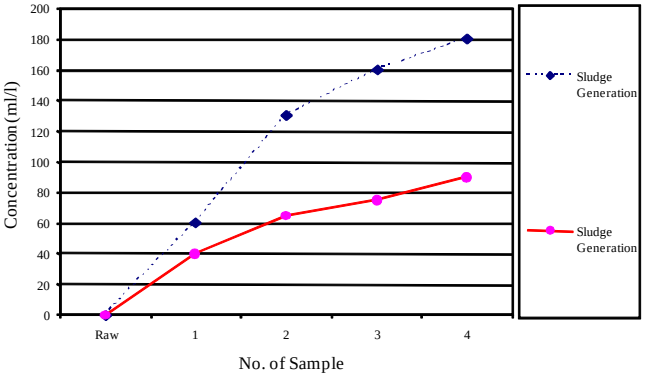

Figure 9 : Comparison with sludge generation

TABLE 1 : Chemical cost analyses

No.	Using Chemical	Average Chemical Dosing	Rate of Chemical (Rs. / kg)	For Use 5MLD (kg/day)	Rs. for 5MLD/day
1	Lime	8-30 mg/l	2.5	40-150	100-375
2	Ferrous Sulphate	67-85 mg/l	3.5	335-425	1172.50-1487.50
3	Alum	60-85 mg/l	4.0	300-425	1200-1700

tively. Alum dosages were taking 62 mg/l, 82 mg/l, 97 mg/l and 101mg/l of solution with respectively increasing pH. The corresponding sludge volume after 30 min. settling have also been recorded and was found to increase with increasing alum dose.

The pH of the sample gradually decreases on in-

creasing alum dose. COD was maintained in under limit, settling lower quantity of sludge with proper color removal. Optimum dose was noted to be 8 - 12 mg/l of Lime with 60 - 85 mg/l of alum with the pH maintained 6.5-7.5.

CONCLUSION

The collection tank was utilized in such a way that settable particle may not enter in the sub sequent units. It was observed that, the flash mixer, where lime was added for enhancing the pH was located at the same location where $FeSO_4$ was to be added. At this time the CETP was working with under utilization capacity with respect to hydraulic load and organic load too. Lime was efficient for controlling pH but it was not efficient for coagulation. Treatibility study using lime with alum gives 59% maximum reduction of COD, color and minimum sludge generation, as compare to $FeSO_4$. Other parameters like concentration of chemical dose, COD, TDS, TSS and volume of sludge generation shown in Figure No. 5, 6, 7, 8 and 9 comparing with $FeSO_4$ and alum. Dose should be increased to 8 - 12 mg/l lime and the existing dosing of 60 - 85 mg/l alum to ensure give proper treatment of all parameters in limits of pollution control board in CETP.

In the cost benefit analysis (TABLE 1) lime was chipset and showed best coagulation than the other chemicals. Performance of alum was better than the $FeSO_4$. This was slightly costly but evaluate overall performance by operational and maintenance cost was chipset than the other chemicals.

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