TREATABILITY STUDY OF CETP WASTEWATER USING PHYSICO-CHEMICAL PROCESS-A CASE STUDY

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Abstract

The present study is focused on a Common Effluent Treatment Plant (CETP) located at Umaraya, District Baroda. Waste water from about thirty five small and medium scale industries majorly comprising of chemical manufacturing and pharmaceutical industries are treated in this CETP. The incoming wastewater was collected and mixed to prepare samples. They were then oxidized by Fenton's reagent (Fe^{2+}/H_2O_2) reduction in COD and BOD were observed at different H_2O_2 and $FeSO_4$ doses to determine the optimum values. Thereafter pretreated wastewater was subjected to filtration with ordinary charcoal and COD and BOD reductions were noted.COD and BOD reduction of 64.35% and 68.57% respectively was achieved by Fenton's reagent and after filtration the values were well within the disposal standards. The results clearly indicate that conventional system should be replaced by physicochemical process like oxidation and filtration.

Index Terms: *CETP, COD and BOD reduction, Fenton's Reagent, Charcoal Filtration*

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1. INTRODUCTION

During the last few years the concept of CETP for the different small and medium scale industrial estates in the Gujarat state has developed with a great speed. One of these CETP has been established for the cluster of industries in western side of Baroda district particularly between Padra Taluka and Jambusar Taluka. M/s Enviro Infrastructure Co. Ltd. (EICL), village Umaraya, Taluka Padra has set up a Common Effluent Treatment Plant (CETP). The plant is located on Effluent Channel Road. The CETP was commissioned on 1st May 2000. CETP was set up to cater Small and Medium scale industries situated in and around Padra & Jambusar Districts.

These small scale industries go on expanding and as per the market demand they change their processes also. Therefore the composite wastewater strength on which a CETP is designed is also getting changed in every couple of years. Because of these changes in the parameters of the composite wastewater it is observed that the present CETP is not able to treat the composite effluent in an efficient manner. It may happen that the entire biological treatment along with the primary treatment also gets totally and /or partially disturbed. The study here is aimed for some modifications in the CETP, for maintaining two of the important parameter COD and BOD of the treated waste water from CETP as they do not meet the required GPCB (Gujarat Pollution Control Board) disposal standards to discharge into ECP (Effluent Channel Pipe) which is a closed effluent channel that carries the effluent to Bay of Cambay.

This is achieved by oxidizing the wastewater by Fenton's reagent (Fe^{2+}/H_2O_2) and then filtering it through ordinary charcoal. The reduction in COD and BOD are observed and design proposal for oxidation and filtration unit is provided. Such advanced physico-chemical processes, can take much higher fluctuating load and characteristics of inlet effluent as compared to conventional biological treatment methods [1].

1.1 Field Study

At present, there are 52 member units, out of which only 35 member industries are discharging their waste water at CETP. As only 35 industries are working the study is carried out only for composite waste water of these industries, discharged into equalization tank of CETP. The following table shows the type of industries and their effluent contributions.

Table -1: Category of Industries and their contribution to the CETP

Sr. No	**Category**	**No of Industries**	**Effluent flow (m^3/d)**
1	Chemical manufacturing industries	25	144
2	Pharmaceutical industries	8	446
3	Glass manufacturing industries	1	10
4	Others	1	0.4
Total flow			600.4

1.2 Present Condition of the CETP

CETP at Umaraya is provided for treatment of about 52 member industries. The present CETP is designed for 2250 m3/d of flow. The present CETP needs modification because though the quantity of flow is very less (600.4 m3/d) than the designed capacity, the parameters like COD, BOD, NH3-N, SS and oil & grease after final treatment comes out to be 450,150, 87.8, 484 and 25mg/L respectively which do not meet the GPCB disposal standard into ECP which are 250,100, 50, 100 and 20 mg/L respectively.

The effluent is received from different industries through a rubber lined tanker. Before the effluent is loaded in the equalization tank, the effluent parameters are measured and then only effluent is loaded in the equalization tank. From here, the effluent is lifted to Flash Mixer. At this tank, continuous dosing of hydrated lime and Aluminum Sulfate (Alum) slurry is added for flocculation and coagulation. After mixing, the effluent is transferred to Primary Settling Tank. As per original treatment scheme (2250 m3/day), two stage Aeration followed by Secondary Clarifier treatment process was provided. As the present effluent quantity is very less only one compartment of Aeration Tank is used. At tertiary treatment level, four Dual Media Filter tanks and chlorination unit is provided.

2. MATERIALS AND METHODS

2.1 Materials

All chemicals employed in this study were analytical grade. All solutions were prepared in distilled-deionized water made on each experimental day. Glassware used in this work was soaked with HNO3 (~10%) for 24 h, and rinsed with distilled-deionized water prior to drying. Hydrogen peroxide was prepared by using the analytical grade (30% by wt.) H2O2 as purchased. The ferrous sulphate heptahydrate (FeSO4.7H2O) was used as the source of Fe2+ in the Fenton process. Solutions of NaOH and HCl were used for pH adjustments. Ordinary charcoal (analytical grade) used as purchased.

2.2 Experimental Procedure

2.2.1Oxidation by Fenton's Reagent

A 100 ml volume samples were prepared by collecting wastewater directly from various tankers coming to CETP on approximately weekly basis and mixing it. There initial COD and BOD was measured and then treated with different H2O2 dose (3, 4,5ml) to obtain optimum dose using 1mg FeSO4, 4 pH, 60 min contact time and 32oC temperature. This process was repeated using optimum H2O2 dose for varying FeSO4 dose (0.5, 1, 1.5, 2mg) and graph was plotted (Chart-1 & 2). The sludge formation was 3ml.

2.2.2 Filtration by Ordinary Charcoal

In the laboratory filter media was prepared using charcoals of size 1 cm. They were filled in burette (standard 50ml) which acted as a filter media column. The height of charcoal column was 7 cm with diameter 4.5 cm. The flow rate through the column was maintained at 60 ml/min. 4ml of 1N NaOH was used to bring pH of wastewater after oxidation from 2.9 to 7.5. Volume and weight of charcoal column was 269.39 cm3 250 gm respectively. Sample volume of 1, 2, 3, 4 L pre treated wastewater were prepared and passed through this filter column. Reduction in COD and BOD were noted as shown in Table 2.

3. RESULTS AND DISCUSSION

After optimization of Fenton's reaction, COD and BOD reduced at optimized pH, H2O2 and FeSO4 dosing was found to be 64.35% and 68.57% respectively. The optimum pH, contact time, H2O2 and FeSO4 dosing was found to be 4, 60 min, 4ml and 1mg respectively at temperature 32oC for the mixed wastewater [2, 3, 4]. The results of filtration with ordinary charcoal are shown in Table 2 [5, 6]. The end result indicates that after filtration, the reduction in COD, BOD, NH3-N, SS and oil & grease values are 82.6%, 91.24%, 54.44%, 81.4% and 40% respectively which meets the disposal standards. Earlier during conventional treatment these values were higher than prescribed standards. Through these tests we can propose modification in the CETP for proper treatment of industrial wastewaters. Design for oxidation and filtration unit to replace the conventional treatment system has been shown in Table 3 [7, 8, 9]. When the analysis work was started out the flow coming to CETP was 600m3/d. At present the flow coming to the CETP is 700 m3/d which is been increased during analysis period of about 6 months. Looking to the present increase in the incoming flow of the CETP, the design has been modified for two times of the present flow coming to the CETP.

There is no need of any additional equalization tank as two numbers of equalization tanks each of capacity 1175 m3 is already present. The clarifier can be used after oxidation process to remove the sludge and then wastewater can be fed to neutralization tank for filtration process. There is no need for any additional filter column. The present columns are sufficient for the treatment only change of media to charcoal is needed.

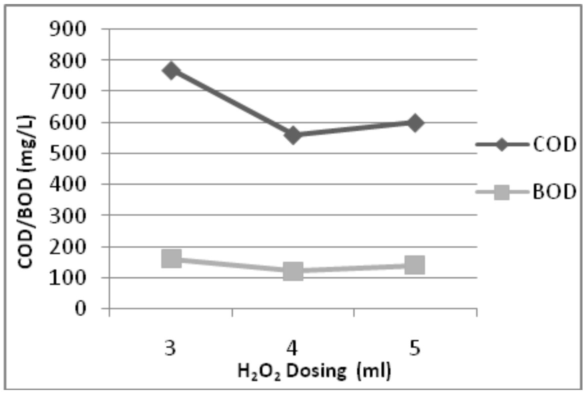

Chart -1: Optimum H2O2 dosing for mixed wastewater

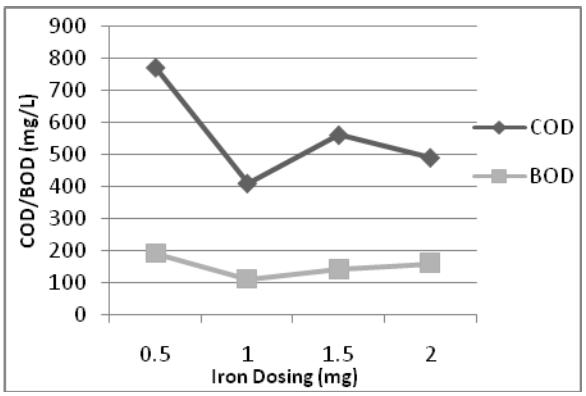

Chart -2: Optimum Iron dosing for mixed wastewater

Table -2: Result of Filtration of pretreated wastewater with ordinary Charcoal

Sample volume (L)	COD mg/L	After filtration COD (mg/L)	COD reduction (%)	BOD mg/L	After filtration BOD (mg/L)	BOD reduction (%)
1	410	200	51.22	110	30	72.72
2		242	40.97		50	54.54
3		310	24.39		75	31.81
4		395	3.66		105	4.54

Table -3: Design of oxidation and filtration unit

Design maximum flow	1400 m^3/d
1 N HCL Solution Tank, 30% H_2O_2 Solution Tank and 1 N	
Quantity of 1 N HCL used	4 ml/L
Total quantity of 1 N HCL	5.6 m^3/day
Depth	1.3 m + 0.3 m FB
Surface area	4.30 m^2
Configuration	Circular with *Dia* = 2.35
1 N HCL Mixing Tank For pH Adjustment and 1 N NaOH	
Detention time	30 min
Volume of tank	30 m^3
Depth	3 m + 0.3 m FB
Surface area	10 m^2
Configuration	Square with *L*:*B* = 3.2 m
Power required, P	2.0 HP (2.72 KW)
Power per unit flow	90.78 W
Diameter of impeller	0.64 m
Velocity at the tip of the impeller	3.35 m/sec
Area of blades	0.20 m^2
Size of one blade	0.12m x 0.12m.
Number of blades	14 nos.
H_2O_2 and $FeSO_4$ Mixing Tank	
Detention time	60 min
Volume of tank	58.33 m^3
Depth	3 m + 0.3 m FB
Surface area	19.44 m^2
Configuration	Square with *L*:*B* = 4.4 m
Power required, P	7 HP (5.3 KW)
Power per unit flow	90.78 W
Diameter of impeller	0.88 m
Velocity at the tip of the impeller	4.6 m/sec
Area of blades	0. 14 m^2
Size of one blade	0.12m x 0.12m.
Number of blades	10 nos.
Design Of Settling (Neutralization)Tank	
Design average flow	700 m^3/day
Influent Pipe Diameter	100mm
Surface area of tank	23.8 m^2
Diameter of tank	5.5 m
Detention time	30 min
Depth of tank	2.80 m
Design Of Simple Charcoal Filter:-	
Design average flow	700 m^3/day
Filtration rate	5 m^3/ m^2. hr
Surface wash rate	0.061 m^3/m^2.min
Minimum Filtration cycle	24 hr
Filter media size	1.0 cm

CONCLUSIONS

From the above experiments we can conclude that conventional biological treatment of the CETP should be replaced with physico-chemical process like advanced oxidation process and filtration unit as incoming COD value is more than 1000mg/L majorly consisting of non-biodegradable load. The oxidation and filtration should be carried out with Fenton's reagent and ordinary charcoal.

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