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Performance Evaluation of Common Effluent Treatment Plant for Tanneries at Vaniyambadi, Vellore, Tamil Nadu

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ABSTRACT

The present study has been undertaken to evaluate performance efficiency of the Common Effluent Treatment Plant (CETP) at Vaniyambadi, Vellore. Waste water samples were collected at four different stages of the treatment units and analysed for various physico-chemical parameters such as pH, temperature, turbidity, EC, TSS, TDS, BOD, COD and heavy metals. The values obtained for different parameters were compared with standard values given by National Environmental Quality Standards (NEQS) for waste water quality. The CETP has been working with the norms of NEQS and Tamil Nadu Pollution Control Board (TNPCB) and meeting the standard discharge limits.

INTRODUCTION

The tanning production process is practically the transformation of raw animal hides into leather and related products. The hides are converted into leather (tanning) by means of tanning agents which are either natural organic substances (tannins) or Cr^{3+} salts. The discharged effluents are some of the most polluting industrial wastes. Their treatment and disposal is, therefore, vital for protection of the environment.

Most of the tanneries are located in clusters in river basins, for example, in the Gangetic basin in Uttar Pradesh and West Bengal, Palar river basin in North Arcot, Cauvery river basin in Erode and Trichurapalli districts of Tamil Nadu. With the rapid growth of tanneries since the mid-seventies, the adoption of chrome tanning process by most tanners and the continued discharge of untreated effluents into land and water bodies, the pollution load increased at rapid rates (Sankar 1998/2000).

The unplanned manner in which the tannery units have come up, it is important to think about their disposal of liquid effluents. The quality of discharged waters from tanneries is far from desired level of acceptance into waterways (UNIDO 1975). As a result, the tanneries are forced to construct a Common Effluent Treatment Plant (CETP). Tamil Nadu Pollution Control Board accorded permission to resume the operation of those tanneries, which put up full-fledged Effluent Treatment Plant (ETP) or (CETP). The treatment of tannery effluent depends on the efficiency with which the CETP functions.

Common effluent treatment plant at Vaniyambadi caters to the wastewater treatment needs of 110 tanneries. It is designed to handle 290 cubic meters per day of saline wastes and 2,832 cubic meters per day of composite effluents. This CETP has a central solar evaporation facility with the largest pan area available in the country pertaining to such an application in the leather industry. The total pan area measures about 65,000 square meters equivalent to nearly 7,00,000 square feet.

Govindasamy et al. (2006) evaluated the performance of tannery effluent treatment plant at Pallavaram, Tamil Nadu. Water samples were collected at different stages of treatment and analysed for the major water quality parameters such as pH, TSS, TDS, BOD, and COD. The efficiency of each stage in removing the pollutants was calculated. The generated data presented the evidence that the effluent treatment plant has been working with the norms of TNPCB. Therefore, the CETPs are perceived to be a feasible solution for abatement of industrial wastewater pollution.

The present study was undertaken to evaluate the performance efficiency of a CETP at Vaniyambadi, Vellore in Tamil Nadu.

MATERIALS AND METHODS

Sampling: The samples were collected from a Common Effluent Treatment Plant (CETP), Vaniyambadi, Vellore district. Sampling was carried out at four different stages of CETP from equalization tank, primary clarifier, aeration tank and final outlet. The water samples were collected in sampling bottles containing nitric acid (10 % v/v). The temperature and pH of the wastewater were determined on the spot using portable pH meter. All the samples were analysed as outlined in the standard methods for the examination of wastewater (APHA 1995)

Sample preparation: Sample was prepared following the method (Manivanan, 2006). The sample was thoroughly mixed by shaking and 100 mL of it was transferred into a glass beaker of 250 mL volume, to which 5mL of conc. nitric acid was added and heated to boil till the volume was reduced to about 15-20 mL. Again conc. Nitric acid was added in increments of 5mL till all the residue were completely dissolved. The mixture was cooled, transferred and made up to 100 mL using deionised water.

Metal analysis: Heavy metal analysis was performed by an Atomic Absorption Spectrophotometer (Model: Varian AA-240). Operational conditions were adjusted to yield optimal determination. The calibration curves were prepared separately for metals by running suitable concentrations of the standard solutions. Digested samples were aspired into fuel rich air acetylene flame and the concentrations of the metals were determined from the calibration curves. Average values of two replicates were taken for determination (Nick Athanasopoulos 2002).

Treatment units: The design of the CETP envisaged the segregation of tannery wastewaters into two streams – saline wastewaters that would be charged in impervious pans and solar evaporated, and the composite effluent would undergo a physical, chemical and biological treatment for the reduction of organic pollution load in the waste streams.

Physical treatment: The segregated wastewaters in the tanneries are carried by gravity through underground sewers and flow into two pumping stations from where they are pumped to the site of the CETP. Where the topography does not permit the flow of wastewater by gravity, two lift stations are located at vantage points from where they are pumped through a pressure line to the main pumping station. In the CETP site, the saline wastewaters are directly charged into impervious pans (constructed using concrete cement) and allowed to solar evaporate.

The composite effluents are collected in an equalization tank and thoroughly mixed and equalized. Equalization is essential as biological treatment systems cannot absorb the swinging shocks of alkalinity, acidity, and high and low organic loads. The effluent is now pumped through screen chambers that remove coarse particles like hair, fleshings, scraps of skin and other wastes. Before passage through the screens, the volume of wastewater is measured by means of electromagnetic flow meter and logged onto a flow totaliser to handle these data. The flow totaliser provides the operator instantaneous as well as all cumulative readings for the day.

Chemical treatment: The wastewater now moves to the stage where chemical treatment is effected by adding such chemicals that promote coagulation of suspended solids, thereby aggregating and settling to the bottom of the primary clarifier from where it is under drawn as primary sludge. However, without the addition of flocculates and coagulants, this CETP is able to achieve 70-75 % suspended solids removal using plain sedimentation. The primary sludge is pumped into sludge drying beds and dried using freely available solar heat. A portion of the sludge is also taken to a plate and frame filter press that dewaters the sludge in a short span of time and the cake can be readily disposed off in the temporary storage facility available at the CETP site. The dewatered sludge is stored in a temporary land fill site developed within the CETP premise.

Biological treatment: The supernatant from the primary clarifier flows to the anaerobic lagoon which is designed with a retention time of 10 days and a BOD reduction efficiency of about 60-65%. The organic waste having been digested to the extent of efficiency of the aerobic lagoon, now flows into the aerobic lagoon with a designed for retention time of 5 days equivalent to the total inflow into CETP. Four fixed aerators with power of 200 H.P. provide the bacteria its oxygen requirements. As the aerobic lagoon works in conjunction with the anaerobic lagoon, it is inevitable that sizeable levels of regenerated sulphides flow into the former. Hence, two floating aerators of 15 H.P. each are placed in the aerobic lagoon and at the points which would oxidize sulphides into sulphates. It should be noted that the major degradation of wastes present in tannery wastewaters have been cleaned up at this stage. The quantum of organic load that has escaped these two lagoons is safely and completely digested by the aerobic bacteria present in the second aerobic lagoon. The treated water flows into the final clarifier where the mixed liquor suspended solids settle at the bottom and are periodically drawn and recycled back into the aerobic lagoons.

RESULTS AND DISCUSSION

To evaluate the pollutants of the tannery samples, various physico-chemical parameters were analysed following the standard methodologies (Manivanan 2006). The wastewater quality data obtained after carrying out the analytical studies are depicted in Table 1.

The total suspended solids (TSS) ranged from 118.4 to 1036 mg/L, the total dissolved solids (TDS) from 3.50 to 43.7 mg/L and total solids (TS) from 121.9 to 1079.7 mg/L. The lower values of these in the final outlet were found to be within the permissible limits of National Environmental Quality Standards (NEQS). The values of TSS and TDS at different stages of treatment process are represented in Fig. 1 and Fig. 2.

The BOD of the samples ranged from 133.4 to 837 mg/L, and the COD from 148 to 2260 mg/L. The BOD and COD values of the final outlet were within the permissible limit of NEQS, while the raw samples have their values much higher than NEQS levels. The values of BOD and COD at different stages of treatment process are given in Fig. 3 and Fig. 4.

The values for other parameters like sulphates ranged from 534 to 1418mg/L, chlorides from 48.1 to 277 mg/L, hardness from 62 to 106 mg/L, nitrates from 4.2 to 8 mg/L, sulphides from 1.08 to 170.16 mg/L, ammonia nitrogen from 64.92 to 139.37, nitrates from 4.2 to 8 mg/L, TKN from 61.53 to 202.56 mg/L, phosphates from 4.5 to 6.01 mg/L, and oils and fats from 1.70 to 5.73 mg/L.

The chromium concentration in the raw effluent and final outlet ranged from 0.456 to 16.186

Table 1: Physico-chemical characteristics of the tannery effluents.

Sno	Parameters	Equalization Tank	Primary Clarifier	Aeration Tank	Final Outlet
1	pH	8.03	7.93	7.46	8.27
2	Color	Black	Grey	Grey	Colorless
3	Temperature (°C)	36.2°C	32°C	33°C	34°C
4	Turbidity (NTU)	163	142	137	100
5	Conductivity (dSm^{-1})	5330	5060	4650	3060
6	Total dissolved solids (mg/L)	43.7	22.18	17.56	3.50
7	Total suspended solids (mg/L)	1036	624.4	632.8	118.4
8	Total solids (mg/L)	1079.7	646.1	650.36	121.9
9	COD (mg/L)	2260	1987	1785	148
10	BOD (mg/L)	837	736	661	133.4
11	Sulphides (mg/L)	170.16	165.84	125.16	1.08
12	Sulphates (mg/L)	1418	1382	1043	534
13	Chlorides (mg/L)	277	216	150.5	48.1
14	Nitrates (mg/L)	8	7.2	5	4.2
15	Hardness (mg/L)	106	98	87	62
16	NH_3 (mg/L)	169.23	149.91	128.71	38.83
17	NO_2 (mg/L)	1.38	0.99	0.46	0.41
18	NO_3 (mg/L)	278	249	203	53
19	Ammonia Nitrogen (mg/L)	139.37	123.46	106.00	64.92
20	NO_2-N (mg/L)	0.42	0.30	0.14	0.12
21	NO_3-N (mg/L)	62.77	56.23	45.84	16.48
22	TKN (mg/L)	202.56	179.98	151.98	61.53
23	Phosphates (mg/L)	6.01	5.74	5.03	4.5
24	Oil and fats (mg/L)	5.73	4.11	1.91	1.70

Table 2: Metal analysis of effluents (mg/L).

S. No	Sample description	Chromium	Cadmium	Lead	Nickel	Copper	Zinc
1.	Equalization Tank	16.186	0.290	2.39	3.406	0.626	0.497
2.	Primary Clarifier	4.512	0.087	1.01	0.086	0.072	0.331
3.	Aeration Tank	0.503	0.053	0.58	0.061	0.048	0.253
4.	Final Outlet	0.456	0.048	0.36	0.058	0.045	0.245

mg/L. The total chromium cencentrations at different stages of treatment process are presented in Fig. 5. Other metals such as copper ranged from 0.045 to 0.626 mg/L, cadmium from 0.048 to 0.29 mg/L and zinc from 0.245 to 0.497 mg/L. The concentration of the metals in the raw effluent were found to have higher values than the NEQS standards, but the effluent from the final outlet of the treatment plant showed metal concentration within the limit of NEQS standards.

CONCLUSION

On the basis of the present data, obtained for various physico-chemical parameters as well as heavy metals from the CETP of Vaniambadi, Vellore, it may be concluded that the treatment effected in this CETP has been meeting standards set by the Tamil Nadu Pollution Control board. The results from the final outlet are within the safe limits of NEQS also. Tannery is a highly polluting industry. In Indian context, there is a need for finding a cost effective and sustainable solution to environmen-

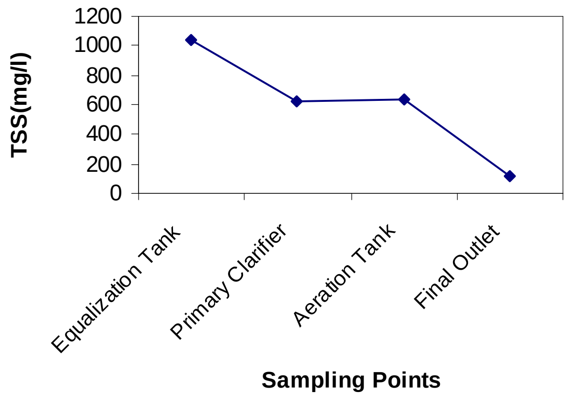

Fig. 1: TSS at different stages of treatment.

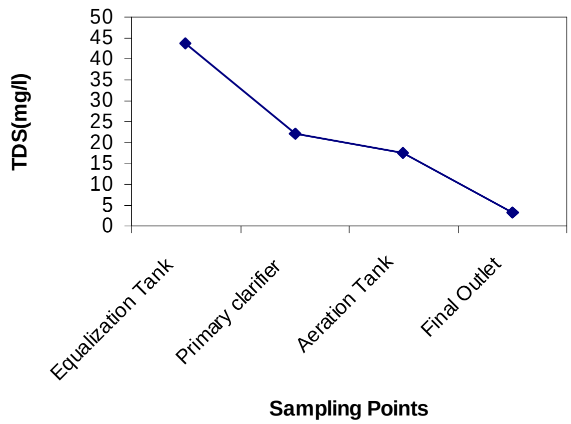

Fig. 2: TDS at different stages of treatment.

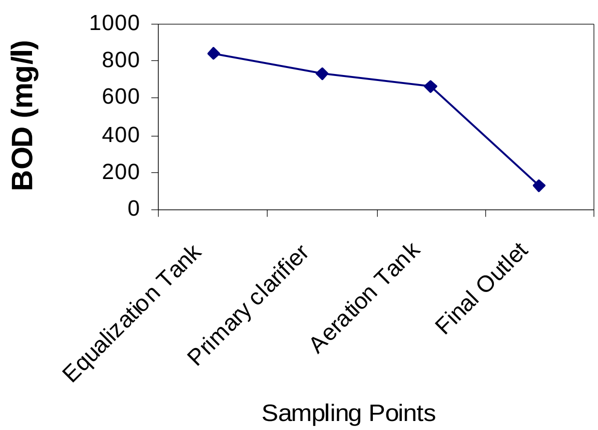

Fig. 3: BOD at different stages of treatment.

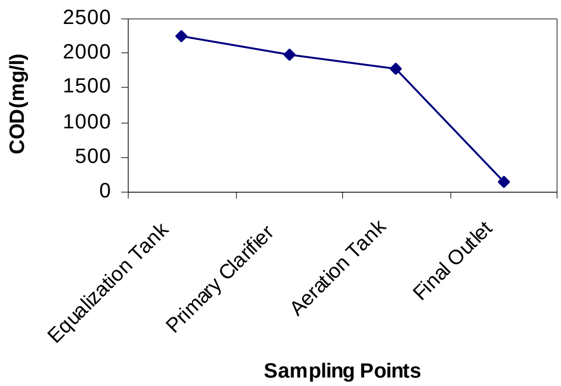

Fig. 4: COD at different stages of treatment.

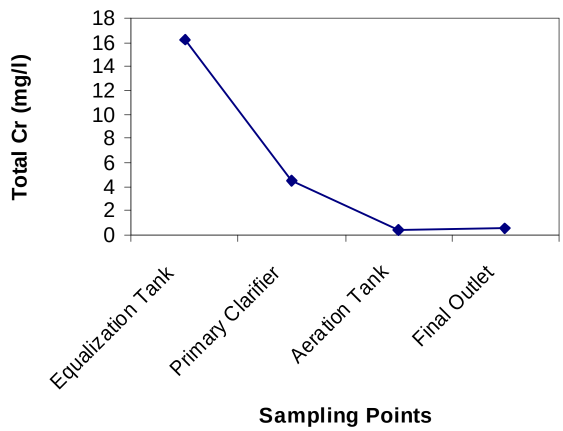

Fig. 4: Total Cr concentration at different stages of treatment.

tal problems caused by tanneries. CETP itself can seek technical assistance from Universities, Institutions and International agencies on pollution abatement, recovery and reuse of water, chemicals and safe disposal of wastes. Therefore, the tanners must use CETP as an Institutional mechanism for solving the environmental problems caused by them.

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