UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL IN THE TANNING INDUSTRY IN SOUTH EAST ASIA

US/RAS/92/120-MODEL CETPs

September 2001

COMMON EFFLUENT TREATMENT PLANT VISHTEC, MELVISHARAM, INDIA

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LIST OF SYMBOLS & ABBREVIATIONS

BOD_5	:	Biochemical oxygen demand, 5 days
BoD	:	Board of directors
CETP	:	Common effluent treatment plant
COD	:	Chemical oxygen demand
CO_2	:	Carbon dioxide
cm	:	Centimetre
^0C	:	Degree Celsius
DS	:	Dry solids
D	:	Day
dia/ϕ	:	Diameter
FB	:	Free board
F/M	:	Food to micro organism ratio
h	:	Hour(s)
HRT	:	Hydraulic retention time
HDPE	:	High density poly ethylene
INR	:	Indian Rupees
kg	:	Kilogram(s)
kW	:	Kilowatt(s)
I	:	Litre(s)
m^3	:	Cubic meter (1000 litres)
mg/1	:	Milligrams per litre
min	:	Minutes
MLSS	:	Mixed Liquor Suspended Solids
MLVSS	:	Mixed Liquor Volatile Suspended Solids
ND	:	Not detected
no	:	Number
RPM	:	Revolutions per minute
pH	:	Negative logarithm of hydrogen ion concentration
SWD	:	Side water depth
SDB	:	Sludge drying beds
US $	:	US Dollar(s)
TNPCB	:	Tamil Nadu Pollution Control Board
TDS	:	Total dissolved solids
t	:	Tonne (1000 kg)
W	:	Watt(s)

Rate of exchange: 1 US $ = INR 46.80

1. INTRODUCTION

Ranipet is an industrial town in the state of Tamil Nadu. It is one of the important leather tanning centres of India. There are about 280 tanneries operating in and around this town. To treat the effluent from these tanneries six common effluent treatment plants were planned in the area. Three of these have been completed and are operational. Of these, the common effluent treatment plant managed by Visharam Tanners Enviro Controls Limited, CETP-Vishtec in short, is located at Melvisharam, 130 km from Chennai (Madras), on the Visharam-Kathivadi road, off the Chennai-Bangalore national highway.

The Common Effluent Treatment Plant is managed by CETP-Vishtec, a company formed by the 37 tanners who are its members. The company is registered under the Indian Companies Act and managed by a BoD, drawn from its members.

2. GENERAL INFORMATION

Total number of tanneries	37
Number of tanneries operating now	22
Number of tanneries processing raw hides/skins to semi finished stage	16
Number of tanneries processing raw hides to finished leather	6
Raw material processed	Buffalo & cow calf hides
Total production capacity of tanneries, as per design of CETP	88,000 kg/day
Current production in the cluster	41,000 kg/day
Number of tanneries doing chrome tanning	5
Number of tanneries doing vegetable tanning	17
Approximate ratio of chrome tannery effluent: vegetable tannery effluent	35:65
Designed flow rate to the CETP	3400 m^3/day
Current flow rate to the CETP	710 m^3/day
Commissioning date of the CETP	August 1996
Total area covered by the CETP	1.3 hectares
Total length of effluent conveyance pipeline	2.5 km
Number of pumping stations	2
Total project cost in Indian rupees	49 million

3. FEATURES OF THE CETP

This CETP is the ninth to be commissioned for treatment of tannery effluent in Tamil Nadu, India. The special features of the CETP are its compact design and fully aerobic biological treatment. The CETP also hosts a number of pilot and demonstration units implemented by UNIDO under its Regional Programme (US/RAS/92/120).

4. PROJECT PLANNING & EXECUTION

4.1. Design

IIT, Madras and Enkem Engineers, Chennai provided the basic design of the plant.

4.2. Finance

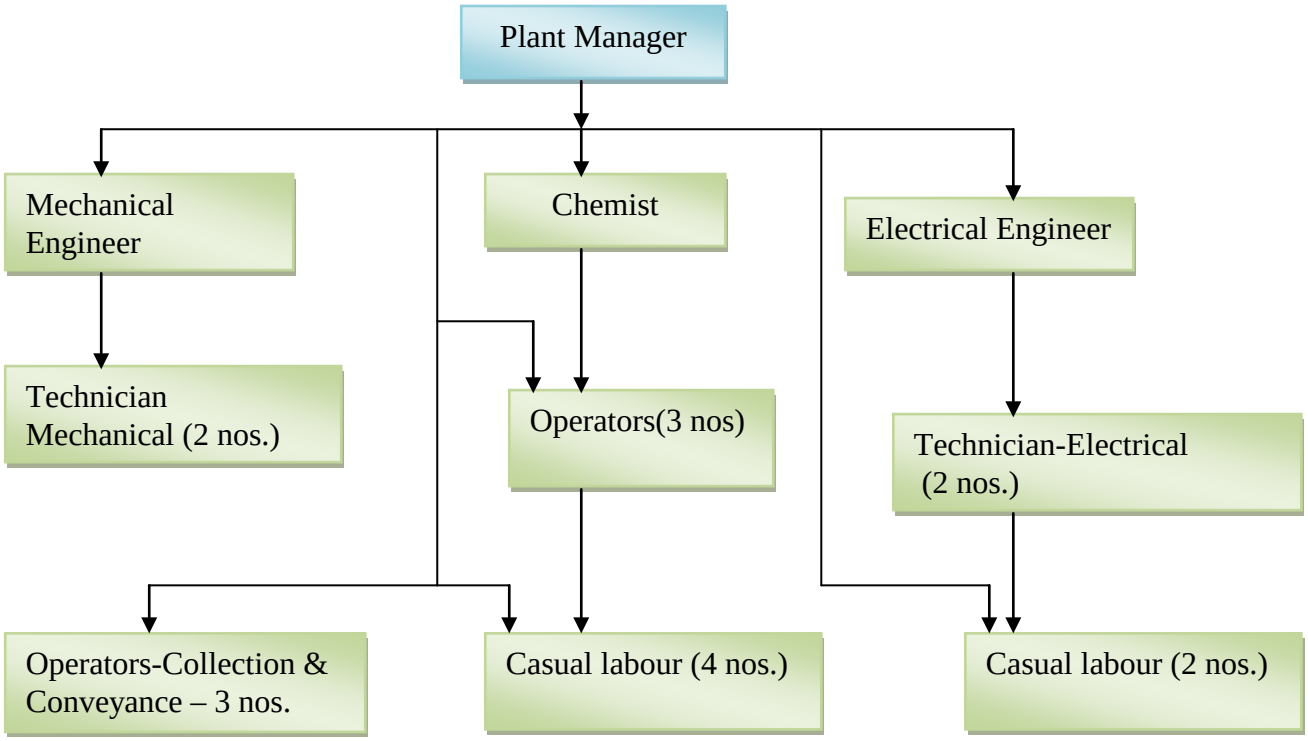
The total investment in the CETP is INR 49 million, of which INR 5 million each were received from the central & state governments as grant and INR. 9.6 million, contributed as equity by the tanneries. The remainder of INR 28.4 million was raised as loan from Industrial Development Bank of India (IDBI).

4.3. Implementation

The project was implemented by CETP-Vishtec directly. M/s. Enkem Engineers, Chennai undertook the construction of the CETP on turnkey basis. Construction of the plant commenced in February 1995 and the plant was commissioned in August 1996.

4.4. Management

The overall management of the CETP is carried out by the BoD and the day-to-day administration by a plant manager, who is a qualified engineer. The organigram of the CETP as at present is as follows:



4.5. Recovery of operational cost

The cost of operation and maintenance of the plant, repayment of loan with interest and other expenditures relating to the management of the plant are covered by monthly contributions made by the tanner members according to their respective production capacity. The rate of recovery is fixed at INR 7 per kg of raw material processed. Besides, for special purposes and emergencies, adhoc collections are made from the tanner members pro-rata.

5. PRE-TREATMENT SYSTEMS IN TANNERIES

5.1. Chrome segregation.

Out of five chrome-tanning units, two tanneries have their own chrome recovery units. Other tanneries are small ones doing chrome tanning only occasionally. These small units segregate the chrome liquor, collect it in a tank and precipitate the chrome by adding magnesium oxide solution. A private company, Chemways, Ranipet, takes the precipitated chrome sludge. This company regenerates chrome by adding sulphuric acid and sells the recovered chromium, after mixing fresh basic chromium sulphate in it as required, to the small tanneries in Ranipet on a commercial basis.

5.2. Pre-treatment of effluent other than chrome liquor

The pre-treatment system in individual tanneries connected to CETP-Vishtec comprises of the following:

1. Segregation of saline effluent streams i.e. soak & pickle liquor and evaporation in solar evaporation pans within the premises of each tannery. The solar pans have been designed on the basis of evaporation rate of 4.5 mm/day.

2. Screening and pre-settling of other combined effluent in a pre-treatment unit and removal and disposal of screenings and grit.

The area specified for the solar evaporation pans as well as the size of pre-treatment units depend on the production capacity of the tannery. According to norms presented by TNPCB 222 m^2 of solar pan area is required to evaporate 1 m^3 of saline effluent per day. A typical pre-treatment unit is shown in Dwg. 1, Annex 2.

5.3. Collection & conveyance system

The CETP has two collection wells to collect effluent discharged by the tanneries after pre-treatment. Effluent from the collection wells is pumped to the CETP receiving sump. Effluent from three tanneries reaches the CETP through a gravity line.

The sketch of collection & conveyance system is enclosed at Dwg 2, Annex 2.

6. TREATMENT PROCESS

The general layout and process flow chart of the CETP are enclosed at Dwg. 3 & Dwg. 4, Annex 2.

The effluent collected in the receiving sump is pumped through a manually cleaned coarse screen to the equalisation tank, provided with five floating aerators for homogenisation of effluent and oxidation of sulphides.

The equalised effluent is pumped to the flash mixer where alum, lime and polyelectrolyte slurry are added.

The effluent then enters a clariflocculator. The chemical sludge settles at the bottom of the clariflocculator. The physico-chemical treatment removes approximately 30-40% of BOD, 35-45% of COD and almost all chromium.

The overflow of the clariflocculator is admitted into two aeration tanks, operating in series, six fixed type mechanical aerators in the first tank and four in the second tank, for biological stabilisation of the effluent.

The biological treatment removes 90-95% of BOD and 85-90% of COD. The overflow of the aeration tank with active biological solids is admitted to a secondary clarifier. The settled sludge in the clarifier is pumped back to the aeration tank to maintain the MLSS at the required level. Some quantity of sludge, which is wasted, is sent to the sludge thickener.

The overflow of the clarifier is taken to a polishing pond in which the effluent is subjected to good settling and some reduction in organics through the action of algae etc. is also obtained. The overflow of polishing pond, which is the treated effluent, is discharged into a nullah, which ultimately joins river Palar. Provision for subjecting the effluent to a tertiary treatment by chemical addition at the inlet of polishing pond is available for use if and when further reduction of colour and suspended solids are desired.

The sludge settled during the physico-chemical treatment in the clariflocculator is taken to a sludge well from which it is pumped to a sludge thickener. The thickened sludge is dewatered in sludge drying beds. The dewatered sludge is disposed of. The CETP has been regularly operating for the past over 5 years.

In August 1999, the CETP, with the assistance of UNIDO, had set up a safe landfill, of 2700 m^3 capacity, for disposal of sludge. Currently the sludge of the CETP is dumped here.

Fig. 1: Landfill at CETP

The key operations of the CETP are now controlled through a centralised instrumentation control system installed with the technical assistance of UNIDO in July 99. The system provides for automatic regulation of aerator operation with respect to prevailing DO levels, automatic chemical dosing with respect to pH and flow rates and programmed operation of all components of the CETP.

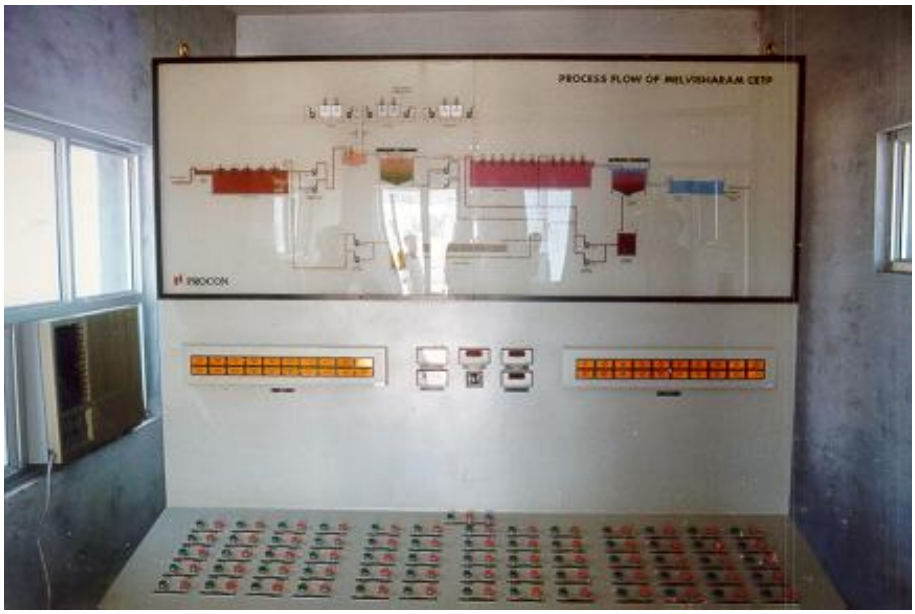


Fig. 2: Centralised instrumentation system at the CETP

7. CETP COMPONENTS & THEIR SPECIFICATIONS

Treatment step	Description/service	Dimension/capacity
	Plant design capacity	3400 m^3/day
Primary Treatment		
Coarse screening	2 nos. manually cleaned screens	15 mm bar spacing
Pumping	Receiving sump of 130 m^3, 3 nos. submersible pumps, 22.4 kW each	Retention time 20 min Pump capacity 400 m^3/h each
Fine screening	One no. self cleaning drum-screen	3 mm bar spacing, 450 m^3/h
Equalisation	1 circular tank	Capacity 2,560 m^3, retention time 18 h
	Aeration/mixing: five numbers high speed floating aerator 7.5 kW each	Specific mixing power 14.6 W/m^3
Equalised effluent pumping	2 nos. centrifugal pumps of 11.2 kW each	Capacity 170 m^3/h each
Flocculation	Flash mixer with 0.75 kW agitator Chemicals: alum (Al_2SO_4. 16 H_2O_2), lime ($Ca(OH)_2$) and Polymer	Capacity 2.5 m^3 Retention time 1 min
Primary sedimentation	1 circular clariflocculator with sludge scraper 16 m dia, flocculator portion 8 m dia with comb type mechanism	Capacity clarifier 560 m^3 , Flocculator 140 m^3 Retention time clarifier 3.3 h Flocculator 50 min
Biological treatment		
Biological aeration	2 nos. rectangular tanks operating in series with 6 nos. low speed fixed aerators 22.4 kW each in first tank and four numbers similar aerators in second tank	Capacity first tank 3,840 m^3, second tank 1840 m^3 Total retention time 1.67 days Specific mixing power 39 W/m^3
Sedimentation	1 circular tank 15 m dia Recycle of biological sludge: 2 nos. centrifugal pumps 5.6 kW each	Capacity 440 m^3, retention time 2.6 h Pump capacity 45 m^3/h each
Polishing	1 rectangular tank with baffles for flow diversion	Capacity 1,500 m^3, retention time 8.8 h
Sludge treatment		
Max. design capacity	about 3,000-6,000 tonnes DS per year	
Sludge pumping	1 primary sludge well with 2 nos. centrifugal sludge pump 7.5 kW each	Capacity 85 m^3 Pump capacity 70 m^3/h each
Sludge holding	1 no. sludge holding/thickening tank	Capacity 170 m^3
Sludge dewatering	8 nos. sludge drying beds, one circular filtrate sump and two centrifugal pumps 3.7 kW each	Total area 3,000 m^2 Filtrate sump capacity 38.5 m^3 Pump capacity 20 m^3/h each

Note: The addresses of suppliers may be seen at Annex 1.
The dimensions of the tanks can be seen in the drawings at Annex 2..

8. OPERATIONAL PARAMETERS OF THE CETP

8.1. Operational parameters

Operational parameter	
Chemical dosages	200-300 ppm of alum and 300 ppm of lime. Anionic polyelectrolytes at the rate of 1 ppm.
Nutrients	No nutrients are added at present
Dissolved oxygen in aeration tank	DO level in both aeration tanks is kept at around 3.0 mg/1
Sludge re-circulation rate	Around 60%
MLSS concentration in aeration tank	3,500 mg/1 against design level of 4,000 mg/1)
Wasting of bio sludge	Approximately 5% of the aerobic bio sludge is wasted daily.
Screenings removal and sludge withdrawal timing	The screenings from screens are removed once a shift. Sludge from primary clarifier is withdrawn once every 30 minutes.
Sludge treatment	
Solids consistency of wet sludge.	3-4% at primary clarifier underflow & 6% at underflow of thickener
Sludge drying beds	10-15 days
Approximate sludge characteristics of dried sludge removed from SDB	Moisture: 76% (humid sludge), calcium: 2-4%, metal hydroxides: 1-3%, chromium: 0.4-1%, silt, sand, etc. 3-6%, organic matter: balance (all dry wt)
Maintenance	
Oiling & greasing cycle	15 and 20 days respectively
Frequency of painting structures by epoxy	Once in three months
Power consumption	
Total connected load	356.6 kW
Operating load	294.7 kW
Capacity of diesel generating set	452 KVA
Safety Measures	
Fire fighting system in the CETP	7 fire buckets & I CO_2 type fire extinguisher
No. of personnel trained in industrial safety measures	2
First aid provisions	One first aid box with necessary medicines as prescribed has been provided
CETP operation monitoring	
Log sheets maintained in the CETP	• Lab registers • Daily pumping details • Chemical dosages • Spares register • Complaints register • Lubrication charts

8.2. Laboratory

The CETP has a laboratory, accommodated in a room in the first floor of the main office/chemical house. The testing equipment and other apparatus available in the laboratory are as follows:

#	Item	Quantity
1.	Spectrophotometer	1 No.
2.	Flame photometer	1 No.
3.	BOD incubator	1 No.
4.	Pocket pH meter	1 No.
5.	Refrigerator	1 No.
6.	Hot air oven	1 No.
7.	Fume cupboard	1 No.
8.	COD apparatus	1 No.
9.	Distilled water still	1 No.
10.	Electric Bunsen	1 No.
11.	Heating mantels	2 Nos.
12.	Vacuum pump	1 No.
13.	Glass wares and chemicals	Full set as required

8.3. Analyses done

Parameter	Equalisation tank outlet	Primary clarifier outlet	Aeration tanks	Secondary clarifier outlet
pH	Daily	Daily	Daily	Daily
COD	Daily	Daily	Daily	Daily
TDS	Daily	Daily	Daily	Daily
TSS	Daily	Daily	Daily	Daily
BOD	Daily	Daily	Daily	Daily
Chlorides	Daily		Daily	Daily
MLSS			Daily	
DO			Daily	Daily

8.4. Personnel

Technical personnel working in CETP-Vishtec are:

Position	Background
Plant manager	M.Sc. in Chemistry with diploma in environmental science
Chemist	B.Sc. in Chemistry, 3 years experience in effluent testing and CETP monitoring
Mechanical Engineer	Diploma in Mechanical Engineering, 3 years experience in effluent treatment projects
Electrical Engineer	Diploma in Electrical Engineering, 6 years experience in effluent treatment projects
Technician (Mechanical - 2 Nos.)	ITI Certificate in fitter trade, 9 years experience in effluent treatment projects
Technician (Electrical - 2 Nos.)	ITI Certificate in Electrical Trade, 4 & 5 years experience in electrical installation respectively.
CETP operators (3 Nos.)	Intermediate with 1-2 years experience in CETP maintenance & operation.

Besides, 6 skilled workers are engaged in the CETP (total staff strength 17) and 3 technicians are engaged in operation of collection and conveyance system.

Note: ***Previously the CETP had a staff of 41 and following implementation of instrumentation control of CETP operation, the number of staff has been reduced to 17. The surplus employees were provided with job in another CETP.***

9. EFFLUENT CHARACTERISTICS BEFORE AND AFTER TREATMENT

(Average for the period from December 2000 to June 2001)

#	Parameter	Unit	Raw effluent	After chemical treatment	Final treated effluent	TNPCB norms*
1.	pH		7.7	7.8	7.8	5.5 – 9.0
2.	Suspended solids	mg/l	2,912	312	82	100
3.	BOD_5	mg/l	1,512	550	29	30
4.	COD	mg/1	3,732	2,210	318	250
5.	Chromium	mg/l	18	2	0.2	2
6.	Sulphides	mg/l	62	16	0.5	2
7.	TDS	mg/1	11,150	10,650	10,610	2,100

*for discharge to inland surface waters

10. COST OF TREATMENT

(Average for the period from December 1999 to June 2001)

Cost component	Cost in Indian Rupees	Cost in US $
Power	321,415	6,868
Chemicals	59,410	1,269
Salary & labour	52,220	1,116
Repair and maintenance	19,520	417
Laboratory analysis	3,200	68
Sludge dewatering	15,420	329
Miscellaneous	10,000	214
Consents & license	2,250	48
Loan repayment	355,520	7,597
Other costs (R&D etc.) lumpsum	200,000	4,274
Depreciation on investment	339,166	7,247
Total	1,378,121	29,447

Treatment cost per cubic meter of effluent : INR 64.7 (US$ 1.38)
Cost/kg of BOD removed : INR 43.6 (US$ 0.93)
Cost/kg of COD removed : INR 18.9 (US$ 0.41)

11. UNIDO ASSISTANCE

At the request of the company, UNIDO had done a detailed assessment of the CETP and identified specific measures for upgrading this as a model CETP. A detailed report on upgradation was prepared in May 1996. The major recommendations included:

- Improved maintenance of collection and conveyance system.
- Providing a centralised collection and transport system for sludge removed from pre-treatment units in the tanneries.
- Providing an additional aerator in the equalisation tank.
- Construction of additional sludge drying beds.
- Obtaining additional laboratory instruments such as a spectrophotometer and a flame photometer.
- Providing centralised instrumentation and control for better operation and monitoring.
- Improved operation and maintenance.
- OSH improvement measures including provision of PPE.

Based on a time frame, the following measures were carried out in the CETP, with the technical assistance of UNIDO:

- Providing a mechanical self-cleaning screen at the inlet of equalisation tank.
- Providing an additional floating aerator (7.4 kW) in equalisation tank.
- Providing one each of sludge tank (6 m^3 capacity) & mobile sludge pump (3.7 kW, screw pump) for sludge collection and transportation from pre-treatment units.
- Construction of two more sludge drying beds.
- Implementation of complete instrumentation control system for direct operation and monitoring of the system.
- Providing partition in the equalisation tank to improve mixing in the low inflow conditions.
- Supplementing the environmental laboratory with additional instruments (Spectrophotometer & flame photometer)

The total cost of the UNIDO interventions worked out to US$ 95,000, which however, does not include the cost of software support of the UNIDO technical team to the CETP on a regular and continuous basis.

Besides this, a number of training workshops were organised, participated by key staff of the CETP. This also included training in Occupational Safety & Health (OSH).

The CETP hosts the following UNIDO assisted pilot and demonstration units (PDUs):

- A reed bed with capacity to treat 50 m^3/d of primary treated effluent
- A biomethanation plant of 5 t/d capacity for sludge and fleshing
- A model safe sludge landfill, 2,700 m^3 capacity
- Composting of sludge with locally available organic wastes (since completed)

Fig. 3: A view of the reed bed at the CETP

Fig. 4: A view of the biomethanation plant at the CETP

12. CLRI/NEERI INTERVENTION

In 1997, AISHTMA (The All India Skin and Hide Tanners & Merchants Association) had engaged Central Leather Research Institute (CLRI) and National Environmental Engineering Research Institute (NEERI), the two leading national organisations, to study the tanneries connected to the CETPs and the CETPs themselves with a view to identify scope for improvement. While CLRI focused its efforts towards introduction of cleaner technologies in the tanneries connected to the CETP, NEERI gave recommendations on optimisation of the CETP operation. NEERI's main recommendations relating to the CETP were:

1. Chrome bearing wastewater should be segregated in tanneries.
2. Replacement of receiving sump pumps by pumps of same capacity with self-actuating system.
3. Replacement of equalised effluent transfer pumps by pumps of lower capacity.
4. Modification of chemical dosing by optimum dosage through lab trials.
5. Increase in free board of sludge carrying channel.
6. Baffling in polishing pond
7. Online flow meter & pH meter
8. An additional secondary clarifier
9. Safe landfill for sludge
10. High Rate Transpiration System (A system which envisages high rate evapotranspiration of saline wastewater by irrigation of salt resistant/ absorbing trees)

Of these the CETP has implemented:

1. Segregation of chrome bearing wastewater in tanneries.
2. Repairing of receiving sump pumps.
3. Modification of chemical dosing.
4. Baffling in polishing pond.
5. Online flow meter & pH meter (later with UNIDO assistance).
6. Safe landfill for sludge (later with UNIDO assistance)
7. High Rate Transpiration System (experimental unit, treating a small part of treated effluent)

The CLRI/NEERI project was completed by the end of 1997.

13. UNIDO'S ASSESSMENT

With the modifications carried out in the CETP with active assistance of UNIDO, good improvement in CETP performance has been achieved. The analysis reports prior to the upgradation (end of 1997 - May 1998) and after upgradation (June 98 onwards) indicates approximately 58% further reduction in suspended solids, 25% in BOD values and 12% further reduction in COD values.

The drawbacks observed, areas with scope for improvement and the recommendations of UNIDO in this regard are given below:

Present drawbacks/scope for improvement	Recommendations
Presently the CETP receives only around 15-20% of the deigned effluent flow. The burden of operation and maintenance of the entire CETP including fixed costs like loan repayment, manpower costs etc. is being borne by the few tanners who are connected to the CETP.	Reaching at least 50% of the deigned flow would reduce the financial burden on the existing tanners and faster implementation of the tanneries under construction will help achieve this.
The collection of funds from individual members is not regular and arrears to the tune of INR 12 million are pending.	Improvement in the collection of funds from individual tanner members will help effective operation & maintenance of the CETP.
Maintenance of the CETP can be further improved as some of the units have already been corroded.	Better maintenance of structures of the CETP by way of proper lubrication and painting will ensure longer life for these.
The current flow to the flash mixer and subsequent units not regulated to be distributed through out the day resulting in overloading of these units.	Regulation of equalised effluent transfer pumps to achieve flow distributed uniformly through out the day.
Some more improvement in organisation structure is possible, particularly in maintenance.	Qualified and experienced mechanical and civil engineers are required to ensure good operation and maintenance of the CETP.
The instrumentation system can be further improved by incorporating a man-machine interface (MMI)	The MMI will improve control of the unit besides facilitating better data collection.

Annexe-I
List & address of suppliers of equipment

Item	Supplier	Local service person/agent
CETP turnkey contractor/supplier of all drives	Enkem Engineers P. Ltd., 824, Poonamallee High Road Chennai 600 010. Tel: 91-44- 641 1362 / 642 8992 Fax: 91-44-641 1788	Enkem Engineers P. Ltd., 824, Poonamallee High Road Chennai 600 010. Tel: 91-44- 641 1362 / 642 8992 Fax: 91-44-641 1788
Submersible Pumps	Kishor Pumps Ltd. A - 13/H, MIDC, Pimpri Pune 411 018 India Tel: 91-20-772 616 / 773 570	Beam Engineers 102, Mogappair Chennai 600 050 India Tel: 91-44-625 7915
Centrifugal Pumps	Johnson pumps, No. 3, Anthu Street, Santhome, Chennai 600 004 India. Tel: 91-44-4933341 Fax: 91-44-4941176 e-mail: pumps@mds.ateel.com	Fabriken Agencies P. Ltd, 11, 7th Cross St, Shastri nagar, Adyar, Chennai-600 020 India Tel: 91-44-4462605/4460602 Fax: 91-44-4461359/4913601 e-mail: sridhark123@eth.net
Screw Pumps	Alpha Helical Pumps, 2/131-A, Venkitapuram Road Venkitapuram Post, Coimbatore: 641 014 India Ph: 91-422-827329/828469/470 Fax: 91-44-827298 e-mail:corporate@alphapumps.com	Alpha Helical Pumps, Asha Mansion, 3rd Floor 59A, Montieth Road Egmore, Chennai 600 008 India Tel: 91-44-8413262/8418171 Fax: 91-44-8555018 e-mail: chennai@alphapumps.com
Instrumentation Control Panel	Procon Instrumentation P. Ltd. G.S.T. Road Urappakkam – 603 202 Kanchipuram District Tel/Fax: 91-4114-65339/65 453	Procon Instrumentation P. Ltd. 1, H. Sakthi Towers 766, Anna Salai Chennai: 600 002 Tel/Fax: 91-44-852 4942
Floating Aerator	Biotim Polutech Ltd. 1, A Electrical Industrial Estate, Kakkalur Thiruvallur. 602 003 Tel: 91-4116-60 271	Biotim Polutech Ltd Tiam House 28, Rajaji Salai Chennai. 600 001 Tel: 91-44-5223223 e-mail: ravichandrank@murugappa.co.in