UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

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

US/RAS/92/120-MODEL CETPs

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COMMON EFFLUENT TREATMENT PLANT AMBURTEC, AMBUR, INDIA

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TABLE OF CONTENTS

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
^oC	:	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)
l	:	Litre(s)
m^3	:	Cubic meter (1000 litres)
mg/l	:	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)
TDS	:	Total dissolved solids
TNPCB	:	Tamil Nadu Pollution Control Board
t	:	Tonne (1000 kg)
W	:	Watts

Rate of exchange: 1 US$ = INR 46.80

1. INTRODUCTION

Ambur, an industrial town in the state of Tamil Nadu, is one of the important leather tanning centers in India. There are about 90 tanneries operating in and around this town. To treat the wastewater from these tanneries two common effluent treatment plants and several individual effluent treatment plants have been constructed and are operational. Of these, the common effluent treatment plant managed by Ambur Tannery Effluent Treatment Company Limited, AMBURTEC in short, is located at Thuthipet, about 8 km from Ambur on the Ambur-Pernambut road.

The CETP is managed by AMBURTEC, a company formed by the 49 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	49
Number of tanneries operating now	41
Number of tanneries processing raw hides/skins to semi finished stage	32
Number of tanneries processing raw hides to finished leather	9
Raw material processed	Cow hides, goat & sheep skins
Total production capacity of tanneries, as per design of CETP	85,500 kg/day
Current production in the cluster	38,000 kg/day
Number of tanneries doing chrome tanning	27
Number of tanneries doing vegetable tanning	14
Approximate ratio of chrome tannery effluent: vegetable tannery effluent	65:35
Designed flow rate to the CETP	2200 m^3/day
Current flow rate to the CETP	1100 m^3/day
Commissioning date of the CETP	December 1995
Total area covered by the CETP	1.4 hectares
Total length of effluent conveyance pipeline	8.5 km
Number of pumping stations	2
Total project cost in Indian rupees	39.5 million

3. FEATURES OF THE CETP

This CETP is the sixth to be commissioned for treatment of tannery effluent in Tamil Nadu, India. This is the only CETP for tanneries in India equipped with oxidation ditches for biological treatment. Originally the CETP was provided with an anaerobic contact filter, later abandoned due to operational problems.

4. PROJECT PLANNING & EXECUTION

4.1. Design

A Chennai-based company, AWACS LTD, made the basic design of the CETP.

4.2. Finance

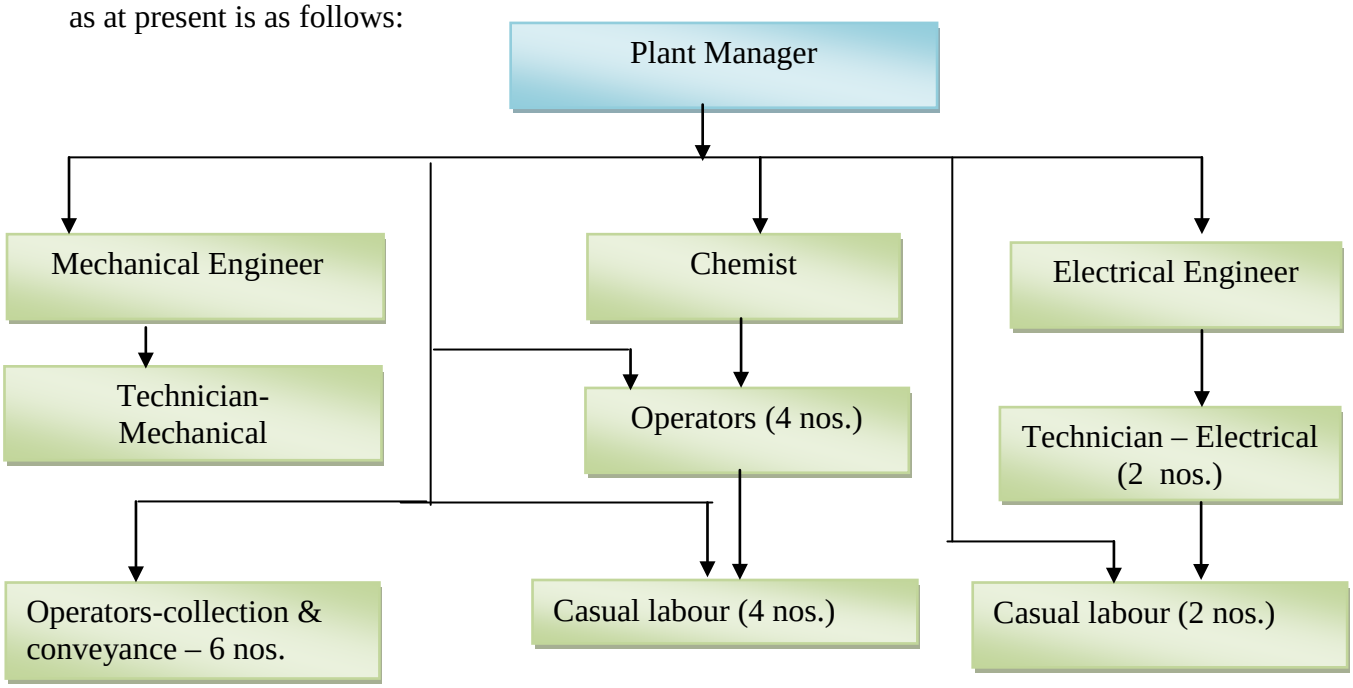
The total investment in the Common Effluent Treatment Plant is INR 39.5 million, of which INR 9 million each were received from the central & state governments as grant and INR 8 million was contributed as equity by the tanneries. The remainder of INR 13.5 million was raised as loan from financial institutions.

4.3. Implementation

The project was implemented by Tamil Nadu Leather Development Corporation Limited (TALCO), a public sector undertaking of the government of Tamil Nadu. M/s. Crompton Greaves Limited, Chennai undertook the construction of the CETP on turnkey basis. Construction of the plant commenced in March 1994 and the plant was commissioned in December 1995.

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 organisation 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 13 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

Nine tanneries have installed chrome recovery system until now and others are in the process of installing such units. A good quantity of chrome is removed in the sludge settled in pre-settling tanks in the pre-treatment units within the tanneries.

5.2. Pre-treatment of effluent other than chrome liquor

The pre-treatment system provided in individual tanneries connected to Amburtec CETP 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 the average evaporation rate of 4.5 mm/day.
2. Screening and pre-settling of combined effluent other than spent chrome liquor 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 prescribed 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.

6. ORIGINAL DESIGN & TREATMENT PROCESS

As per the original design and installation, the CETP had two stage biological system with an anaerobic contact filter as the first stage and four oxidation ditches equipped with cage rotors as the second stage.

The treatment system as per the original design was as follows:

The effluent collected in the receiving sump was pumped to the equalisation tank provided with three floating aerators for homogenisation of effluent. The equalised effluent was then pumped to the flash mixer where alum and lime were added. The effluent then entered a clariflocculator for settling of the chemical sludge. The overflow of the clariflocculator was admitted into an upflow anaerobic contact filter provided with rubble chips as media. The overflow from the contact filter was admitted into four oxidation ditches, operating in parallel, each provided with two cage rotors at either end for biological stabilisation of the effluent.

The overflow of the oxidation ditches with active biological solids was admitted into a secondary clarifier. The settled sludge in the clarifier was pumped back to the ditches to maintain the MLSS at the required level.

The overflow of the clarifier was discharged as treated effluent.

The sludge settled during the physico-chemical treatment in the clariflocculator, as well as the wasted sludge from the oxidation ditches was taken to the sludge well and pumped to sludge drying beds. The dewatered sludge was disposed of.

7. RE-ENGINEERING OF THE CETP

Some deficiencies, both in the design and construction of the CETP had become apparent soon after the commissioning. First the anaerobic contact filter got choked completely necessitating the complete removal of media from it. Then the cage rotors installed in the oxidation ditches failed due to mechanical problems and their replacement by small aspirators in the ditches hardly helped the treatment. After nearly two years of operation, performance of the CETP had deteriorated dramatically and the BOD_5 levels of the treated effluent rose to > 300 mg/1. A risk of closure of the CETP by TNPCB was looming large. Some tanner members withdrew from the CETP and installed their own ETPs.

At this juncture, the CETP management approached UNIDO for technical assistance in late 1998 and UNIDO readily agreed to assist the CETP in re-engineering the system. A reputed international firm, M/s. TEH-PROJEKT, Croatia, appointed for conducting a thorough study, identified the following areas as requiring improvement:

- Need to protect the collection and conveyance system from coarse solids and to prevent excess suspended solids entering the CETP;
- Proper pumping system for raw effluent from the receiving sump; and screening of the effluent by manual and mechanical screens, to prevent excessive solids entering the treatment process;
- Need for adequate mixing and aeration in the equalisation tank, to provide good mixing and oxidation of sulphides;
- Appropriate chemical dosing in the flash mixer and an efficient clariflocculation system;
- Adequate aeration in the oxidation ditches;
- Need for an additional secondary clarifier- with appropriate provision for re-circulation of activated sludge in the pre aeration/oxidation ditches.
- Dewatering of primary and secondary sludge in the sludge drying beds; and,
- Adequate monitoring facilities and practical experience required for effectively managing and operating such a CETP.

The consultant suggested the following remedial measures:

- Improvement of pre treatment units in the individual tanneries
- Installation of coarse screens at the inlet of effluent into the CETP
- Installation of reliable submersible pumps for raw effluent
- Installation of a fine automatic screen before the equalisation tank
- Reconstruction of the existing equalisation tank (by dismantling the walls at the entry and exit points) to prevent settling of solids in areas from where it will be difficult to evacuate these and installation of mixers/aerators of the required capacity

- Installation of a new flocculator mixer and sludge scraper in the primary clariflocculator as the existing one was heavily corroded
- Activation of some of the 24 tanks (previous anaerobic contact filters) as the first step biological activated sludge treatment, by reconstruction of the pipeline system for the primary treated effluent and recycled sludge
- Installation of appropriate and reliable aeration systems in the aeration tanks (oxidation ditches) including consequent modification to the tanks. From the technical point of view brush type aerators were considered the best for this type of treatment. However, two other alternatives - fixed surface aerators and ejectors – were also discussed in the report.
- Construction of a new secondary clarifier (as the existing one did not have the necessary surface capacity to ensure the required concentration of SS in the treated effluent) and to recycle the necessary amount of the MLSS back to the biological activated sludge treatment.
- Installation of measuring channel at the effluent outlet in order to have the possibility of online control of the final treated effluent.
- Reconstruction of the chemical preparation and dosing systems to have easier controlled and better chemical treatment.
- Upgradation of the electrical installations.
- Upgradation of the online instrumentation and introduction of automatic control in order to better monitor and control the treatment process.
- Setting up of the tertiary treatment – the necessity to set this up will depend on the quality of the treated effluent produced by the re-engineered CETP.

These measures were discussed in detail with the CETP management and a phased approach was finalized to implement the re-engineering of the CETP. A MoU was accordingly signed by Amburtec with UNIDO in April 1999, regarding the Phase I, expected to result in considerable improvement in the performance of the CETP. The CETP carried out the following modifications in phase I:

- Providing a spare pump in the receiving sump outlet
- Providing three additional floating aerators each of 11.5 kW in the equalisation tank.
- Installation of a new clariflocculator mechanism
- Carrying out necessary modifications to the oxidation ditches and installation of new fixed aerators each of 18.5 kW- 8 nos. (two in each tank).
- Construction and commissioning of a new secondary clarifier with return sludge pumps.
- Better monitoring facilities, equipped with a multiparameter tester

The re-engineering works were completed in November 2000 and the re-engineered CETP was inaugurated in February 2001.

Fig.1: Oxidation ditches before the re-engineering

Fig.2: Oxidation ditches after the re-engineering

8. TREATMENT PROCESS

The general layout and process flow chart of the re-engineered CETP are enclosed at Annex 2, Drawings 2 & 3.

The effluent collected in the receiving sump is pumped to the equalisation tank provided with five floating aerators for homogenisation of effluent and oxidation of sulphides.

The equalised effluent is then 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 from the clariflocculator is admitted into four oxidation ditches, operating in parallel, each provided with two fixed aerators at either end for biological stabilisation of the effluent.

The biological treatment removes 90-95% of BOD and 85-90% of COD. The overflow of the oxidation ditches with active biological solids is admitted to two secondary clarifiers. The settled sludge in the clarifier is pumped back to the ditches 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 discharged as treated effluent.

The sludge settled during the physico-chemical treatment in the clariflocculator as well as the wasted sludge from the oxidation ditches is taken to sludge well and pumped to sludge drying beds. The dewatered sludge is disposed of.

9. CETP COMPONENTS & THEIR SPECIFICATIONS

Treatment step	Description/service	Dimension/capacity
	Plant design capacity	2200 m^3/day
Primary Treatment		
Pumping	Receiving sump of 190 m^3, one agitator type mixer mounted on float 7.5 kW, 2 nos. centrifugal open impeller pumps 11.2 kW each	Retention time 55 min Pump capacity 210 m^3/h each
Equalisation	1 rectangular tank	Capacity 1,120 m^3, retention time 12 h
	Aeration/mixing: five numbers high speed floating aerator 11.2 kW each	Specific mixing power 50 W/m^3
Equalised effluent pumping	2 nos. centrifugal pumps of 7.5 kW each	Capacity 105 m^3/h each
Flocculation	2 nos. flash mixer operating in series, both fixed with 1.1 kW agitators Chemicals: alum (Al_2SO_4 16 H_2O_2), lime ($Ca(OH)_2$) and anionic polyelectrolyte	Capacity 2 m^3 and 6.4 m^3 each Retention time 1 min and 3.6 min respectively
Primary sedimentation	1 circular clariflocculator with sludge scraper 12 m dia, flocculator portion 6 m dia with two paddle type flocculator mechanism 1.2 kW each	Capacity clarifier 400 m^3, Flocculator 70 m^3 Retention time clarifier 3.8 h Flocculator 40 min
Biological treatment		
Biological aeration	4 nos. carrousel oxidation ditches, (RCC tanks) operating in parallel with 2 nos. each of low speed fixed aerators 18.5 kW installed at both ends of each oxidation ditches, total 8 aerators	Capacity each oxidation ditch 915 m^3, Total retention time 1.66 days Specific mixing power 40 W/m^3
Sedimentation	2 circular tanks 10 m and 12 m dia respectively Recycle of biological sludge: for each clarifier, 2 nos. of centrifugal pumps 3.7 kW each, total 4 pumps	Capacity clarifier-1 235 m^3 and clarifier-2 280 m^3, total retention time 4.9 h Pump capacity 35 m^3/h each
Sludge treatment		
Design capacity	About 2,000-4,000 tonnes DS/y	
Sludge dewatering	20 nos. primary sludge drying beds& 10 nos. secondary sludge drying beds	Total area primary SDB 2,400 m^2, secondary SDB 1,200 m^2.

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...

10. OPERATIONAL PARAMETERS OF THE CETP

10.1. Operational parameters

Operational parameters	
Chemical dosage	200-250 ppm of alum and 200 ppm of lime and 1 ppm polyelectrolyte.
Nutrients	5 kg of sodium phosphate per week
Dissolved oxygen in oxidation ditches	DO levels in all the oxidation ditches are kept at around 3.0 mg/l
Sludge re-circulation rate	Around 100%
MLSS concentration in oxidation ditches	3,000-3,500 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 the screens are removed once a shift. Sludge from primary clarifier is withdrawn once an hour.
Sludge treatment	
Solids consistency of wet sludge.	3-4% at primary clarifier underflow & 6% at underflow of thickener
Sludge drying beds in SDBs	10-15 days
Approximate sludge characteristics of dried sludge removed from SDB	Moisture: 76% (humid sludge), calcium: 2-4%, metal hydroxides: 1-3%, chromium: 1.8-3%, 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 six months
Power consumption	
Total connected load	297 kW
Operating load	202 kW
Capacity ofdiesel generating set	125 KVA, 2 nos,
Safety Measures	
Fire fighting system in the CETP	5 sand buckets & 2 $C0_2$ fire extinguishers
No. of personnel trained in industrial safety measures	One
First aid provisions	One First Aid box with necessary medicine as prescribed has been provided
CETP operation monitoring	
Log sheets maintained in the CETP	a) Lab registers, b) Daily pumping details, c) Chemical dosages, d) Spares register, e) Complaints register f) Lubrication charts

10.2. Laboratory

The CETP has a laboratory, located in a room in the first floor of the main office/chemical house.

10.3. Analyses done

The various analyses done in the laboratory on a daily basis are as follows:

Parameter	Equalisation tank outlet	Primary clarifier outlet	Oxidation dicthes	Secondary clarifier outlet
pH	*	*	*	*
COD	*	*	*	*
TDS	*	*	*	*
BOD	*			*
Chlorides	*			*
MLSS			*	
DO			*	*

10.4. Personnel

Technical personnel working in Amburtec CETP are:

Position	Background
Plant manager	Diploma in mechanical engineering with 8 years experience in CETP operation and maintenance.
Chemist	B.Sc.Chemistry, 3 years experience in effluent testing and CETP monitoring
Mechanical engineer	Diploma in mechanical engineering, 12 years experience in effluent treatment projects
Electrical engineer	Diploma in electrical engineering, 8 years experience in effluent treatment projects
Technician (mechanical - 1 No.)	ITI (Industrial Training Institute) certificate in fitter trade, 3 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 (4 Nos.)	Intermediate with about 2 years experience in CETP maintenance & operation.

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

11. EFFLUENT CHARACTERISTICS BEFORE AND AFTER TREATMENT

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

#	Parameter	Unit	Raw effluent	After chemical treatment	Final treated effluent	TNPCB norms*
1.	pH		7.7	7.35	7.2	5.5 – 9.0
2.	BOD_5	mg/1	985	715	34	30
3.	COD	mg/1	2,352	1,855	285	250
4.	Chromium	mg/1	76	7	1	2
5.	Sulphides	mg/1	85	58	0.2	2
6.	TDS	mg/1	12,125	12,310	12,120	2,100

for discharge to inland surface waters

Note: The above values include the period prior to the re-engineering too. The average value of COD and BOD_5 after November 2001 remained consistently within the specified limit of 250 mg/1 and 30 mg/1 respectively.

12. COST OF TREATMENT

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

#	Cost component	Cost in Indian Rupees	Cost in US $
1.	Power	326,782	6,983
2.	Chemicals	102,656	2,194
3.	Salary & labour	71,420	1,526
4.	Repair and maintenance	54,250	1,159
5.	Laboratory analysis	12,232	261
6.	Sludge dewatering	24,225	518
7.	Miscellaneous	43,422	928
8.	Consents & license	2,917	62
9.	Loan repayment	9,317	199
10.	Other costs (R&D etc.) lumpsom	150,000	3,205
11.	Depreciation on investment	332,350	7,101
	Total	1,129,571	24,136

Treatment cost per cubic meter of effluent : INR 36.8 (US$ 0.78)
Cost/kg of BOD removed : INR 38.74 (US$ 0.83)
Cost/kg of COD removed : INR 17.82 (US$ 0.38)

(RoE 1 US $ = INR 46.80)

13. UNIDO ASSISTANCE

UNIDO assisted AMBURETC in re-engineering the CETP. As a part of the implementation of the re-engineering programme, UNIDO has provided the CETP with:

- Consultancy services by way of engaging an international firm for the study of CETP and designing the re-engineering project.
- Complete aeration system for the oxidation ditches.
- A multiparameter tester.

The total cost of the UNIDO inputs works out to US$ 120,000, which however, does not include the cost of software support of the UNIDO technical team at RePO to the CETP on a regular and continuous basis.

Besides this, a number of training workshops were organised participated by the key staff of the CETP. This also included training in occupational safety & health.

14. CLRI/NEERI INTERVENTIONS

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. Installation of flow measuring device at the inlet of the CETP.
4. Installation of additional aerator in equalisation tank.
5. Demolition of baffle wall in equalisation tank.
6. 24 h operation of the CETP.
7. Optimisation of chemical dosages.
8. De-sludging of receiving sump and equalisation tank.
9. Installation of an extended aeration system
10. Installation of a secondary clarifier for the extended aeration system
11. Installation of additional secondary clarifier for the oxidation ditches.
12. Additional sludge drying beds.
13. Proper and regular monitoring of the treatment process.
14. Safe landfill for sludge
15. High Rate Transpiration System (A system which envisages high rate of evapo-transpiration of saline wastewater by irrigation of salt resistant/ absorbing plants)

Of these the CETP has implemented the following (some of them as a part of the re-engineering plan)

1) Chrome bearing wastewater segregation in tanneries.
2) Installation of additional aerator in equalisation tank.
3) Demolition of baffle wall in equalisation tank.
4) 24 h operation of the CETP.
5) Optimisation of chemical dosages.
6) De-sludging of receiving sump and equalisation tank.
7) Installation of additional secondary clarifier for the oxidation ditches.
8) Proper and regular monitoring of the treatment process.
9) High Rate Transpiration System (experimental unit, treating a small part of treated effluent)

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

15. UNIDO'S ASSESSMENT

With the modifications carried out in the CETP with active assistance of UNIDO, notable improvement has been achieved by the CETP in its performance. Compared to its performance before March 2000, that is before re-engineering, it has been observed that the results, of the period after re-engineering, i.e. after November, 2000, show a reduction in the

BOD value by > 90%.

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

Present drawbacks	Recommendations
Implementation of suggestions listed in TEH-PROJEKT report (Phase 2) could improve the performance of the CETP	With the implementation of these measures, it is possible to make the CETP a model plant.
Presently the CETP receives only around 50-60% of the deigned effluent flow. The cost of operation and maintenance of the CETP therefore tends to be high.	Reaching the designed flow would provide tanners an opportunity to increase their production capacity/construction of additional tanneries in the region and optimize the cost of operation of the CETP too.
The collection of funds from individual members is not regular and arrears to the tune of INR 8 million are pending.	Improvement in the collection of funds from the 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.
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.

Annex – 1
List & Address of suppliers of equipment

Item	Supplier	Local service person/agent
CETP turnkey contractor/supplier of all tanks	Cromption Greeves Limited No.1, Dr. MGR Salai Chennai 600 034 Tel. 91-44-8257375	Cromption Greeves Limited No.1, Dr. MGR Salai Chennai 600 034 Tel. 91-44-8257375
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
Aeration system in oxidation ditches, Clariflocculator, Additional secondary clarifier	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	
Floating Aerator	Enviro Science & Engineering Private Ltd 2-D, Rosewood Offices, 135, Nungambakkam High Road Chennai 600 034 Tel. 8268827/8224043	Enviro Science & Engineering Private Ltd 2-D, Rosewood Offices, 135, Nungambakkam High Road Chennai 600 034 Tel. 8268827/8224043