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 SIDCO, RANIPET, 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	:	centimeter
^0C	:	Celsius
DS	:	dry solids day
d	:	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
pH	:	Negative logarithm of hydrogen ion concentration
SWD	:	Side water depth
US $	:	US Dollar(s)
TNPCB	:	Tamil Nadu Pollution Control Board
t	:	tonne (l000 kg)
W	:	Watts

1. INTRODUCTION

Ranipet is an industrial town in the state of Tamil Nadu. It is one of the important tanning centers 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 Ranipet Sidco Finished Leather Effluent Treatment Co. Ltd is located at SIPCOT Industrial area, Ranipet, 120 Km from Chennai (Madras) on the Chennai-Bangalore road.

The Common Effluent Treatment Plant is managed by Ranipet Finished Leather Effluent Treatment Co. Ltd., in short CETP-SIDCO, a company formed by 86 tanners who are its members. This company is registered under the Indian Companies Act and managed by a BoD, drawn from its members.

2. GENERAL INFORMATION

Total number of tanneries	86
Number of tanneries operating now	81
Number of tanneries processing raw hides/skins to semi finished stage	0
Number of tanneries processing raw hides to finished leather	81
Raw material processed	Buffalo & cow calf hides, goat & sheep skins
Total production capacity of tanneries, as per design of CETP	40,000 kg/day
Current production in the cluster	32,000 kg/day
Number of tanneries processing wet blue leather	17
Number of tanneries processing vegetable tanned leather	64
Designed flow rate to the CETP	2500 m^3/day
Current flow rate to the CETP	1980 m^3/day
Commissioning date of the CETP	January 1996
Total area covered by the CETP	0.8 hectares
Total length of effluent conveyance pipeline	4.9 km
Number of pumping stations	2
Total project cost in Indian rupees	24.2 million

3. FEATURES OF THE CETP

This CETP is the seventh to be commissioned for treatment of tannery effluent in Tamil Nadu, India. In cooperation with UNIDO's Regional Programme for Pollution Control in the Tanning Industry in South East Asia, the CETP had added many innovative features, such as, (1) the first CETP in the region being operated by a team of women and (2) the first CETP to utilize the treated effluent for irrigation of inedible plants.

4. PROJECT PLANNING & EXECUTION

4.1 Design

The basic design of the plant was done by M/s. Enkem Engineers, Chennai.

4.2 Finance

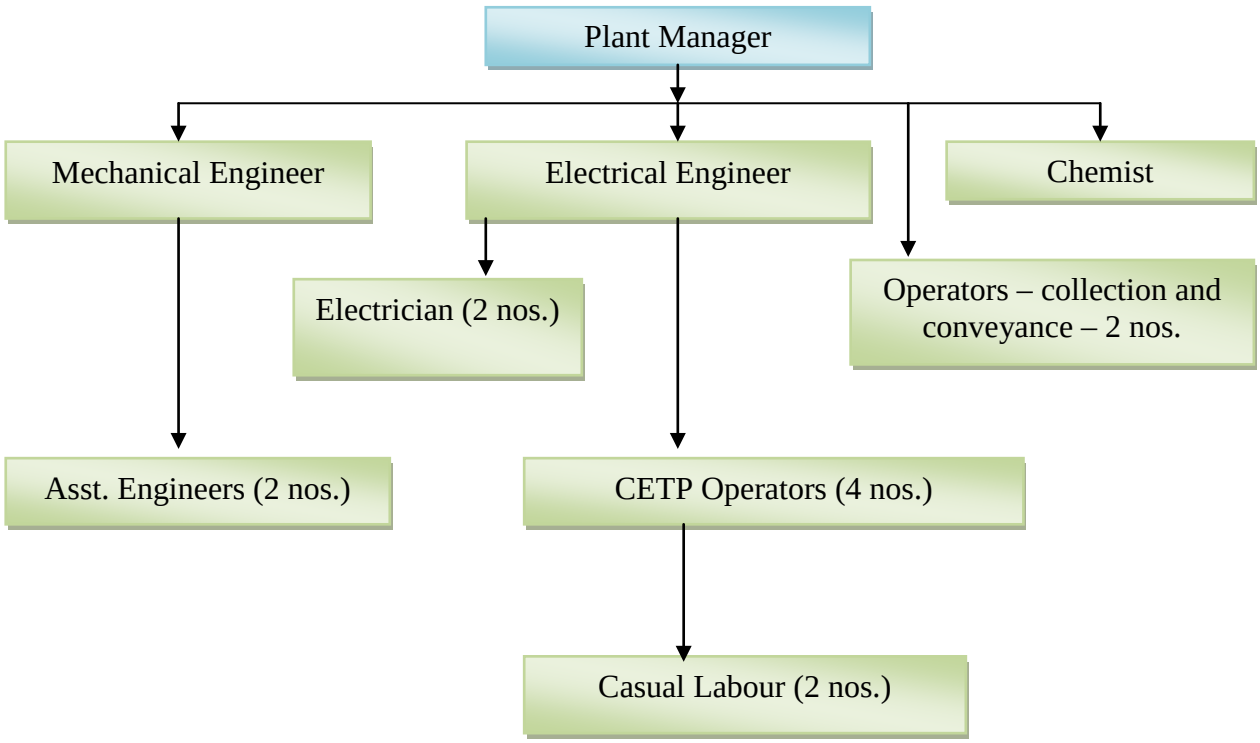
Of the total project cost of INR 24.2 million, 50% was obtained as subsidy from the Government of Tamil Nadu and the Government of India. 20% of the project cost was contributed as equity by the tanners and the remainder was obtained as loan from the Industrial Development Bank of India (IDBI).

4.3 Implementation

CETP-SIDCO implemented the project directly. M/s. Enkem Engineers, Chennai undertook the construction of the CETP on turnkey basis.

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 environmental chemist. 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 any other miscellaneous expenditures are covered by monthly contributions made by the tanner members according to their respective production capacity. The rate of recovery is assessed on the basis of raw material processed and fixed at INR l2/kg. Besides, for special purposes and emergencies, adhoc collections are made from the tanner members pro-rata.

5. PRE-TREATMENT SYSTEMS IN TANNERIES

All the tanneries connected to the CETP have pre-treatment units. The pre-treatment units consist of a settling unit with baffle chamber to arrest floating materials, 2 screens of 10 mm clearance, collection and conveyance and a sludge drying bed. The effluent after pre-treatment is admitted into manholes leading to the CETP effluent collection network. Details of pre-treatment is given in Dwg. 1 in Annex 2.

6. COLLECTION & CONVEYANCE SYSTEM

Of the 81 tanneries currently discharging effluent into the CETP, 65 are directly connected to it and 16 to a collection well. A screen has been installed in the collection well with 10 mm clearance and it is cleaned twice every shift. A diesel generator of 50 kVA is provided in the pumping station. HDPE pipes have been used for all conveyance lines. Gravity lines have 315 mm OD and pumping line 110 mm OD. Around 90% of these lines are laid along the road side and the remaining criss-cross through other places including private property.

7. TREATMENT PROCESS

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

The effluent collected in the receiving sump is pumped to the equalization tank, through a manually cleaned coarse screen, provided with 5 floating aerators for homogenization of effluent and oxidation of sulphides.

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

The effluent thereafter 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, four fixed type mechanical aerators in the first tank and four similar aerators in the second tank, for biological stabilization of the effluent. The two aeration tanks can be operated in series or parallel.

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 well.

The overflow of the clarifier is discharged as treated effluent.

The sludge settled during the physico-chemical treatment in the clariflocculator is taken to sludge well and then part of it is pumped to sludge drying beds and partly to the filter press for dewatering. The dewatered sludge is disposed of in the sludge-dumping site. The CETP has been regularly operated since it's commissioning.

8. CETP COMPONENTS AND EQUIPMENT SPECIFICATIONS

Treatment step	**Description/service**	**Dimension/capacity**
	Plant design capacity	2500 m^3/day
Primary treatment		
Coarse screening	2 nos. manually cleaned screens	15 mm bar spacing
Pumping	Receiving sump of 150 m^3, 2 nos. submersible pumps, 18.5 kW each	Retention time 30 min Pump capacity 250 m^3/h each
Equalisation	1 circular tank	Capacity 2120 m^3, retention time 20 h
	Aeration/mixing: three numbers high speed floating aerator 7.5 kW each	Specific mixing power 10.6 W/m^3
Equalised effluent pumping	2 nos. centrifugal pumps of 7.5 kW each	Capacity 105 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 1.7 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 500 m^3 , Flocculator 100 m^3 Retention time clarifier 4.7 h Flocculator 55 min
Biological treatment		
Biological aeration	2 nos. rectangular tanks with 4 nos. low speed fixed aerators 22.4 kW each in first tank and 4 nos. similar aerators in second tank	Capacity 2800 m^3 each Total retention time 2.3 days Specific mixing power 32 W/m^3
Sedimentation	1 circular tank 14 m dia Recycle of biological sludge: 2 nos. centrifugal pumps 5.6 kW each	Capacity 380 m^3, retention time 3.6 h Pump capacity 45 m^3/h each
Sludge treatment		
Max. design capacity	About 1500-3000 tonnes DS per year	
Sludge holding	1 sludge well	Capacity 60 m^3
Sludge dewatering	8 nos. sludge drying beds	Total area 2400 m^2

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

9. OPERATIONAL PARAMETERS OF THE CETP

9.1 Operational parameters

Operational Parameter	Factors maintained at present
Chemical dosages	100-150 ppm of liquid poly aluminum chloride and 300 ppm of lime. Anionic polyelectrolytes at the rate of 1 ppm
Nutrients	DAP at 5 kg/day to the aeration tank
Dissolved Oxygen	DO level in both aeration tanks are 1.2 mg/1 and 2.5 mg/1 respectively.
Sludge re-circulation	Around 70%
MLSS Concentration	4500 mg/1
Sludge wasting	Approximately 15% of the aerobic bio sludge
Screenings removal and sludge withdrawal timing	The screenings from screens are removed once a shift. Sludge from primary clarifier is withdrawn once in four hours.

Sludge treatment	
Solids consistency	3-4% at primary clarifier underflow
Sludge drying period in sludge drying beds	10-15 days
Approximate characteristics of dried sludge	Moisture: 76% (humid sludge), calcium: 2-4%, metal hydroxide: 1-3%, chromium: 0.8-2%, silt, sand etc. 3-6%, organic matter: balance (all dry wt.)

Maintenance	
Oiling and greasing	15 and 20 days respectively
Frequency of painting of structures	Once a year

Power consumption	
Total connected load	280.5 kW
Operating load	223.8 kW
Capacity of diesel generating set	250 KVA

Safety measures	
Fire fighting system in the CETP	9 fire buckets and 2 CO_2 type fire extinguishers
First aid provisions	One first aid box with necessary medicines as prescribed

CETP operation monitoring	
Log sheets maintained in the CETP	Lab registers Mini forest register Daily pumping details Chemical dosage and stock Spares register Lubrication charts & complaints register

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:

#	Equipment	Nos.
1.	Multi-parameter tester	1
2.	BOD incubator	1
3.	Pocket pH meter	1
4.	Monopan balance	1
5.	Hot air oven	1
6.	COD apparatus	6
7.	Distilled water still	1
8.	Electric Bunsen	2
9.	Heating mantles	1
10.	Vacuum pumps	2
11.	Glass wares	—
12.	Chemicals	—

9.2 Analyses done in the laboratory

Various analyses done in the laboratory are as follows:

Parameter	Raw effluent	Equalised raw effluent	Clariflocculator outlet	Final treated effluent
pH	Daily	Daily	Daily	Daily
Suspended solids	Daily	Daily	Daily	Daily
Total dissolved solids			Daily	Daily
Chlorides		Weekly		Weekly
Sulphides	Weekly	Weekly		
Sulphates		Weekly		Monthly
BOD5	Daily	Daily	Daily	Daily
COD	Daily	Daily	Daily	Daily
Total chromium	Daily	Daily	Daily	Daily
Phosphates		Weekly		Weekly
Ammonia nitrogen		Weekly	Weekly	Weekly
Nitrates				Monthly

Parameter	Aeration tanks	Treated effluent
DO	Daily	Daily
MLSS	Daily	
MLVSS	Daily	

9.3 Personnel

Plant Manager	M.Sc. in chemistry, 8 years experience in CETP operation and monitoring.
Chemist	B.Sc. in chemistry, 4 years experience in effluent testing.
Agricultural specialist	M.Sc. in Botany, 4 years experience
Maintenance engineer	Diploma in Mechanical Engineering, 2 years experience in CETP in CETP maintenance
Electrical Engineer	Diploma in Electrical Engineering, 6 years experience
Sr. Engineer	Diploma in Mechanical Engineering, 4 years experience.
Asst. Engineer – (Mechanical –2)	Diploma in Mechanical Engineering, 2 years experience in CETP maintenance.
Technician (Electrical - 2)	ITI certificate in Electrical Trade.

Besides the above technical people, 4 skilled workers and 2 administrative staff are engaged in CETP operation. All key managerial personnel of this CETP are women.

Fig 1: The managerial staff at the CETP

10. EFFLUENT CHARACTERISTICS BEFORE AND AFTER TREATMENT

(Average for the period from December 99 to June 2001)

#	**Parameters**	**Unit**	**Raw**	**Treated effluent**	**TNPCB norms***
1.	pH		5.1	7.1	5.5 – 9.0
2.	Suspended solids	mg/l	1310	122	100
3.	Total dissolved solids	mg/l	4215	4120	2100
4.	B.O.D, 5 day 20^0 C	mg/l	1235	25	30
5.	COD	mg/l	2940	265	250
6.	Total chromium	mg/l	22	0.2	2
7.	Sulphides	mg/l	18	ND	2

for discharge to inland surface waters

11. COST OF TREATMENT

(Average for the period from December 99 to June 2001)

Cost component	Cost in Indian Rupees	Cost in US $
Power	238,765	5,102
Chemical	72,345	1,546
Salary & labor	31,450	672
Repairs & maintenance	32,250	689
Laboratory analysis	5,740	123
Sludge dewatering & handling	17,420	372
Miscellaneous	10,000	213
Consents & license	2275	49
Loan repayment	212,000	4,530
Other costs (R&D etc.) lumpsum	122,300	2,613
Depreciation on investment	115,000	2,457
Total	859,545	18,366

(Rate of exchange: 1 US $ = INR 46.80)

Treatment cost per cubic meter of effluent: INR 14.47 (US$ 0.31)
Treatment cost per kg of BOD removed: INR 11.96 (US$ 0.26)
Treatment cost per kg of COD removed: INR 5.41 (US$ 0.12)
Total treatment cost per square ft. of leather: INR 0.4 - 0.6 (about one US cent)

12. UNIDO INTERVENTIONS

A filter press with simplified features developed by a local supplier has been installed in the CETP with UNIDO's assistance.

To improve the monitoring in the CETP, UNIDO has provided it with a multiparameter tester to test DO, pH, conductivity and TDS.

Further, with active support of UNIDO, the CETP has initiated a number of experiments involving utilization of treated effluent for irrigational application. Initially a controlled plot with various trees was irrigated with treated effluent and after obtaining satisfactory results viz. absence of ground water/soil contamination, good survival and growth of trees, the experiment was expanded.

Fig.2: Mangium plantation

A view of the mangium plantation in SIDCO, which was a part of the initial experiments, is shown in Figure 2.

The above experiments were done under strict monitoring and it was observed based on the initial analytical values that the ground water was not getting contaminated due to utilization

of effluent for irrigation. The growth of the plants was found to be good.

Fig. 3: Miniforest in Sidco

effluent in the irrigation trial plots, UNIDO proposed rehabilitation of a degraded piece of land where previously all untreated effluent used to accumulate. The project termed as 'mini forest' was completed with assistance of UNIDO in January 1999. A view of the forest is shown in figure 3.

At present, 700-800 m^3/day of effluent discharged by the CETP is used for irrigating the 'mini forest' developed in an area of about 9 acres with approximately 25,000 inedible plants of different varieties.

After observing the positive impact of the treated
The CETP has constructed a secure landfill following the design provided by UNIDO for constructing temporary sludge landfill at Ranitec CETP, Ranipet.

Vermi-composting of the sludge from the CETP has been attempted in two sheds of 100 m^2 area each and 10 heaps have been set up in the CETP.

With technical guidance of UNIDO, the CETP has converted a non-functional existing sand filter bed to a reed bed. The operation of reed bed in vertical feeding as a batch process has been done from July 1998 onwards. The performance of the unit has been found to be good, providing good colour removal and 50-60% of organic removal.

A view of the experimental reed bed is shown in the figure 4.

Fig 4: Reed bed in CETP-SIDCO

13. CLRI/NEERI INTERVENTIONS

In 1997, AISHTMA (All India Skin and Hide Tanners and Merchants Association) had engaged Central Leather Research Institute (CLRI) and National Environmental Engineering Research Institute (NEERI), the two leading national organizations to study the tanneries connected to the CETPs and the CETPs 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 optimization of the CETP's performance. NEERI's main recommendations relating to the CETP were:

1. Replacing pumps in the receiving sump by pumps with self-actuating system.
2. Regularisation of pumping from receiving sump to equalization tank.
3. Desludging of equalization tank and additional mixing in the tank.
4. Optimum chemical dosing
5. Maintenance of MLSS in the range of 3000 - 3500 mg/1.
6. Providing magnetic flow meter
7. Reduction of foaming in aeration tank.
8. Providing tertiary treatment.
9. Disposal of sludge in a safe landfill.
10. High rate transpiration system for effluent disposal.

Of these the CETP has implemented the following:

1. Replacing pump in receiving sump by pumps with self-actuating system.
2. Desludging of equalization tank.
3. Regularization of pumping from receiving sump to equalization tank.
4. Optimum chemical dosing.
5. Maintenance of MLSS.
6. Providing magnetic flow meter.
7. Reduction of foaming in aeration tank.
8. Disposal of sludge in a safe landfill.
9. Use of treated effluent for irrigation, a variation of the HRTS.

14. UNIDO'S ASSESSMENT

The performance of the CETP had been consistently good. With utilization of more effluent in the mini forest project, the CETP could reduce the discharge from the CETP and eventually achieve 'zero discharge' of effluent if sufficient land is earmarked for irrigation. The following measures will further improve the performance of the CETP:

- The CETP treats less than its designed volume. Increasing the influent quantity will reduce the per cubic meter cost of treatment.
- Regular collection of funds from individual tanner members towards operation & maintenance will help the CETP perform better.
- Better maintenance of pre-treatment units will reduce the pollution load on the CETP, besides reducing maintenance problems in the collection and conveyance system.
- Better maintenance of structures of the CETP by way of proper lubrication and painting will ensure longer life of its structures.
- Installation of a reed bed of appropriate capacity as a polishing treatment could reduce the colour and COD in the treated effluent.

Annex-1
List & address of suppliers of equipment

Item	Supplier	Local service person/agent
CETP turnkey Contractor/ supplier of all tanks & drives	Enkem Engineers P. Ltd., 824, Poonamallee High Road, Chennai: 600 010 India Tel: 91-44-6411362/6428992 Fax: 91-44-6411788	Enkem Engineers P. Ltd., 824, Poonamallee High Road, Chennai: 600 010 India Tel: 6411362/6428992 Fax: 6411788
Submersible pumps	Kishor Pumps P. Ltd., A-13/H, MIDC, Pimpri, Pune 411 018 India Ph: 772616/773579	Beam Engineers, 102, Mogappair, Chennai 600 050 India Ph: 91-44-6266465/6257915
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