Sustainable Industrial Waste Water Management for a Industrial development cooperation in Thane, Maharashtra

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Abstract
Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river basins in India and elsewhere are closing or closed and experiencing moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus, wastewater/low quality water is emerging as potential source for demand management after essential treatment. An estimated 38354 million litres per day (MLD) sewage is generated in major cities of India, however only 11786 MLD is treated. Similarly, only 60% of industrial waste water, mostly large scale industries, is treated. Performance of state owned sewage treatment plants, for treating municipal waste water, and common effluent treatment plants, for treating effluent from small scale industries does not comply with prescribed standards. Thus, effluent from the treatment plants, often, not suitable for household purpose and reuse of the waste water is mostly restricted to agricultural and industrial purposes.

LIST OF FIG

Keywords
Common Effluent Treatment Plant, Life cycle assessment, Reuse, Greenhouse gases

INTRODUCTION

Per capita availability of fresh water in India has dropped from 5,177 cubic meters in 1951 to 1,820 cubic meters in 2001. The urban situation faces the same plight, with cities like Bangalore where water is rationed twice a week and for 30 minutes a day in Bhopal. Given the projected growth of population by the year 2025, the per capita availability is likely to drop drastically leading to scarcity. Traditionally, the water sector in India has been owned and operated by the government. The Indian government supports the private sector to contribute and initiate various regulatory reforms. Not being able to solve all problems single-handedly, the government is encouraging the private sector to participate and introduce regulatory reforms. Rapid industrialization is adversely impacting the environment globally. Pollution by inappropriate management of industrial wastewater is one of the major environmental problems in India as well, especially with burgeoning small scale industrial sector in the country. To address the pollution coming out from industries, adoption of cleaner production technologies and waste minimization initiatives are being encouraged. Common Effluent Treatment Plants (CETPs) are considered as one of the viable solution for small to medium enterprises for effective wastewater treatment. However, many of the operating CETPs are not performing optimally due to various technical and managerial reasons. The study has been undertaken to understand the functioning of a CETP and assessing the process w.r.t. to the impacts on environment, cost analysis and further suggesting alternative treatment processes that can help curb impacts. The site being Maharashtra Industrial Development Cooperation (MIDC), Trans Thane Creek(TTC), at Turbhe Navi Mumbai the stretches 21kms and is 2 km wide. The industries of this area include Small Scale, Medium Scale and Large Scale Industries of Paints, Varnishes, Dyes, Chemical, Pharmaceutical, Engineering, IT and Service Industries. Further an alternative is provided to reduce the impacts and make the CETP sustainable with respect to energy, water and environmental cost. The water is discharged after testing, does contain a considerable amount of contamination that is let out into water bodies that have environmental impacts. These impacts can be reduced by introduction of additional processes and recycling the treated water and further use it instead of letting it out in the water bodies. The level of contamination in the sludge can also be reduced and the same can be processed further to generating methane

Methodology

Plant visit and Characterization

Maharashtra Industrial Development Corporation (MIDC) is a project of the government of Maharashtra state in India and is the leading corporation of Maharashtra. MIDC established an industrial estate at Thane Belapur Road, Navi Mumbai in 1963 which is known as TTC MIDC Estate. The Estate is located along Thane Belapur Road towards Northern side of road and total area of the industrial estate is 27 sq.kms. There are about 2200 industrial units of various category engaged in the manufacture of chemicals, dyes, dye-intermediates, Bulk drugs, pharmaceuticals, Textile auxiliaries, Pesticides, Petrochemicals, Textile processors, Engineering units etc. Some of them are generating trade effluent and total effluent quantity from all these unit is 26 MLD.

All the major & medium industries have provided full-fledged effluent treatment plant and the small industries have provided primary effluent treatment plants (ETP). The treated effluent of the industries is discharged into Common Effluent Treatment Plant (CETP) for further treatment and disposal. The effluent is further treated in CETP and then discharged into TTC through closed pipeline at the point recommended by National Institute of Oceanography (NIO). There are two major common infrastructures in TTC MIDC area. One is Common Effluent Treatment Plant (CETP). Capacity of the CETP is 27 MLD and based on extended aerations activated sludge process technology. The treated effluent from the industries is collected through closed pipeline. The CETP comprises of collection / equalization / neutralization sump, Clariflocculator, Aeration tank, clarifier, sludge drying beds & decanter etc. Another infrastructure is Common Hazardous Waste Treatment Storage and Disposal Facility (CHWTSDF) provided by TTC Waste Management Association.

Table1.1 Classification of Industries At MIDC, TTC

SR.	Products	Nos.	%
1)	Chemical	1082	33
2)	Engineering	1260	38
3)	IT & IT Related	615	19
4)	Textile, Dyeing Pharmaceuticals 295	295	9
5)	Service Industries & Misc.	24	1
	TOTAL	**3276**	**100**

(Source: http://www.tbiaindia.org/Industry.html)

Table 1.2 Features Of MIDC, TTC

1. Total Industrial Area	:	2560 Hectares
2. Number of Industries	:	2300/3000
3. Annual Turnover	:	Rs. 7000 crores
4. Payment to Exchequer	:	Rs. 1800 crores
5. Export Potential	:	Rs. 500 crores
6. Employment	:	1,00,000
7. Total Length of TTC Area	:	21 Km.
8. Total Road Length	:	180 Km.
9. Water Sources	:	MIDC
10. Quantity of Water Supply	:	52 MLD
11. Total Sewerage Length	:	34.5 Km.
12. Topography	:	North : Thane City West : Thane Creek South : Belapur East : Hill
14. Power Consumption	:	450 MW
15. Average Rainfall	:	100"

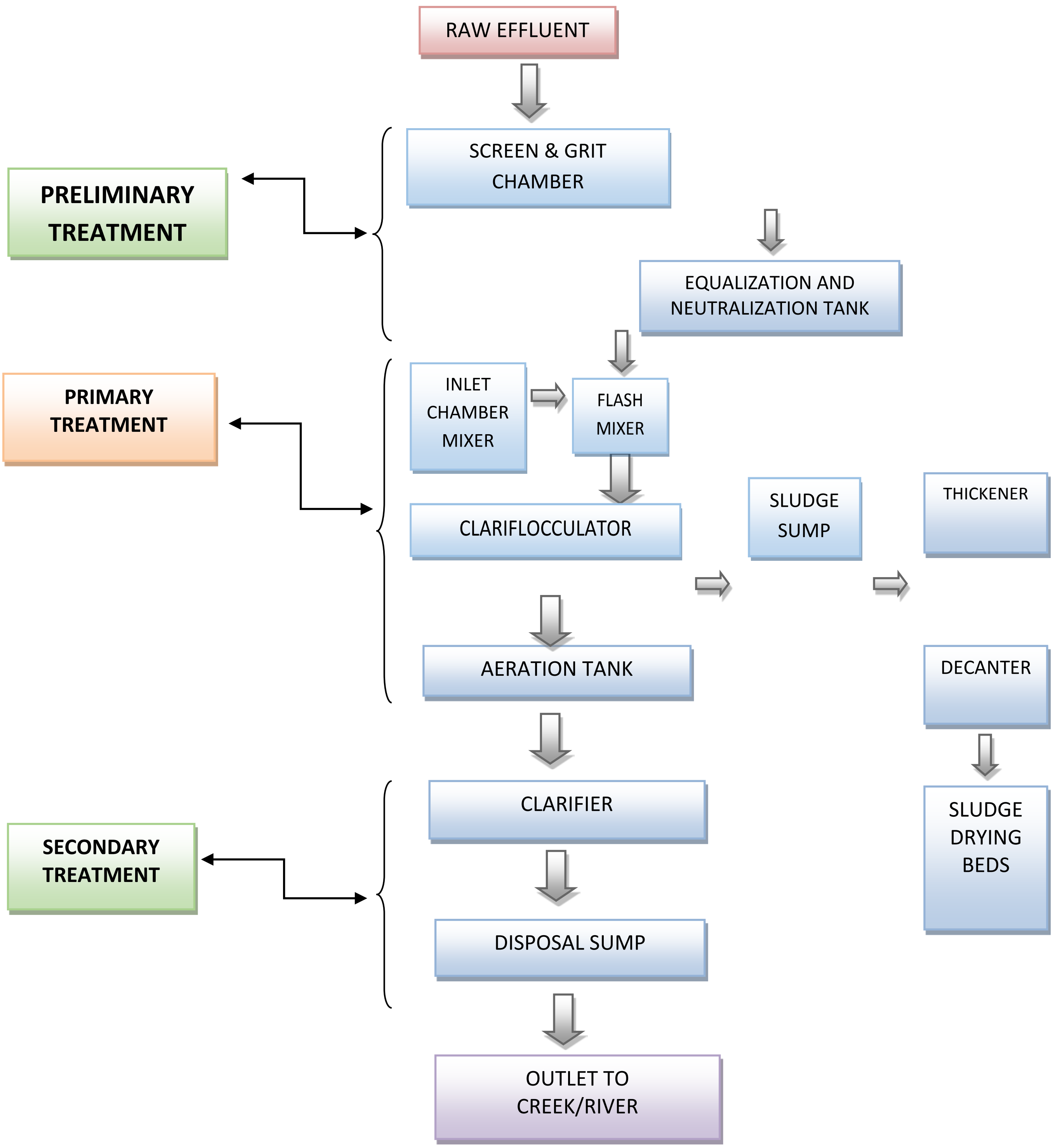


Figure 2.1 Treatment Process of a CETP

CETP, Trans Thane Creek, Process

Screen & Grit Chamber:

The effluents from over 2500 SSI and MSI units is pumped to Pumping Stations at Sanpada and Rabale. The pipelines are then connected to the Preliminary treatment Stage at CETP,TTC. The Preliminary stage includes Screens for removal of solid objects from the effluent. This water further goes to the Grit Chamber that weeds out stone, sand particles.

Equalization & Neutralization Tank:

The water is further pumped to the Equalization Tank where HCl and NaOH(base) is mixed to reduce the acid levels in water. This water is then sent to the neutralization tank where the water is compressed and all the effluents are mixed together to create a homogenous mixture is made.

Inlet Chamber and Flash Mixer:
The water is pumped into the Inlet chamber for sedimentation process. Chemicals like Poly Aluminum Chloride(PAC) and Polycaprolactone (PCl) to settle the suspended solids in water. A dose of Coagulants , Flocculent Polyelectrolyte is added to the Flash Mixer to reduce the settling time.

Clariflocculator:
In the clariflocculator, the water enters the flocculator, where the flocculating paddles enhance flocculation of the feed solids. Heavy particles settle in the bottom and the liquid flows radically upward in the clarifier zone. This clarified liquid is discharged over a peripheral weir into the peripherial launder. The deposited sludge is raked to the bottom where it is routed to the sludge chamber and discharged.

Aeration Tank:
The aeration tanks provide a location where biological treatment of the waste water takes place. In these tanks, microorganisms and waste water in various stages of decomposition are mixed, aerated, and maintained in suspension.

Thickener:
The sludge collected at the sludge sump is then sent to a thickner where the water content in the sludge is reduced.

Sludge Decanter:
In the centrifuge Decanter the sludge gets dewatered. The residual moisture in the dewatered solids determines the disposal costs and the centrate quality determines the pollution load returned back to the treatment facility. Minimizing both must be achieved at the lowest possible cost, with the lowest possible polymer and energy consumption, with low maintenance costs and with the lowest possible number of required operating staff.

Table 2.1 Design, Inlet & Outlet Characteristics of CETP,TTC

Parameters	Design characteristics		Inlet characteristics	Outlet characteristic	Discharge limits
PH mg/l	2.0 to 6.2	4.0 to 7.0	5.5 to 7.5	7.0 to 7.5	5.5 to 9.0
COD mg/l	3200 mg/l	2000 mg/l	900 to 1500	180 to 240	250
BOD mg/l	1000 mg/l	1000 mg/l	400 to 900	10 to 50	100
TSS mg/l	340 mg/l	340 mg/l	100 to 300	25 to 75	100
O&G mg/l	170 mg/l	170 mg/l	25 to 75	< 5	10

Table 2.2 Details of various units of treatment scheme at CETP,TTC

Sr. No.	Units	12 MLD plant		15 MLD plant	
		Capacity (Cum)	Retention Time	Capacity (Cum)	Retention Time
1	Equalisation tank (2 nos.)	2,375 (each)	4.5 hrs	2,500(each)	4.0 hrs
2	Inlet chamber	8	52 sec	10	58 sec
3	Flash mixer	6	39 sec	10	58 sec
4	Clariflocculator	1,716	3.5 hrs	1,980	3.17 hrs
5	Aeraton tank	15,500	31.5 hrs	16,000	25.6 hrs
6	Clarifier	2643	5.25 hrs	3200	5.12 hrs
7	Sludge sump	70	---	125(2 Nos)	---
8	Thickner	280	---	310 (2 Nos	---
9	Filtrate sump	45	---	160	---
10	Sludge drying bed (7 nos.)	400sq.Mt(each)	---	---	---
11	Centrifuge decanter (15 nos.)	1 No.	---	2 Nos	---

Analysis

Cost and environmental analysis

Common Effluent Treatment Plant, TTC, MIDC.

Intensive efforts were made by Thane Belapur Industrial Association (TBIA) to set up a CETP in MIDC, TTC industrial area. The plant of 12 MLD capacity (Phase-I) is in successful operation since 1997. In order to tackle extra load generated by the industries in TTC industrial area, an additional common effluent treatment plant of 15 MLD capacity (Phase-II) was envisaged and is commissioned in 2006. CETP scheme was implemented mainly to tackle the problem of liquid effluent generated especially from small scale industrial units (SSI) who are having techno-economic constraints. The facility was also made available to all medium and large scale industrial units with the aim to strengthen the financial feasibility, to get advantage of mixing of treated effluents and utilize the common single disposal system.

Table 3.1 Process Details

TOTAL CAPACITY : 27 MLD (12MLD + 15 MLD)			
	CAPACITY	**12 MLD**	**15MLD**
1.	Project Start-Up	1994	2002
2.	Project Commissioned	March 1997	March 2006
3.	Project Cost	4.0 Cr.	8.5 Cr.

(Source: http://cpcb.nic.in/divisionsofheadoffice/ess/NaviMumbai.pdf)

Water Environment of neighboring water bodies.

The MIDC has made its own arrangements for supplying water to the industries. There is no direct or indirect discharge of effluent in the water bodies. However, MPCB monitors four Nallas passing through the industrial cluster.

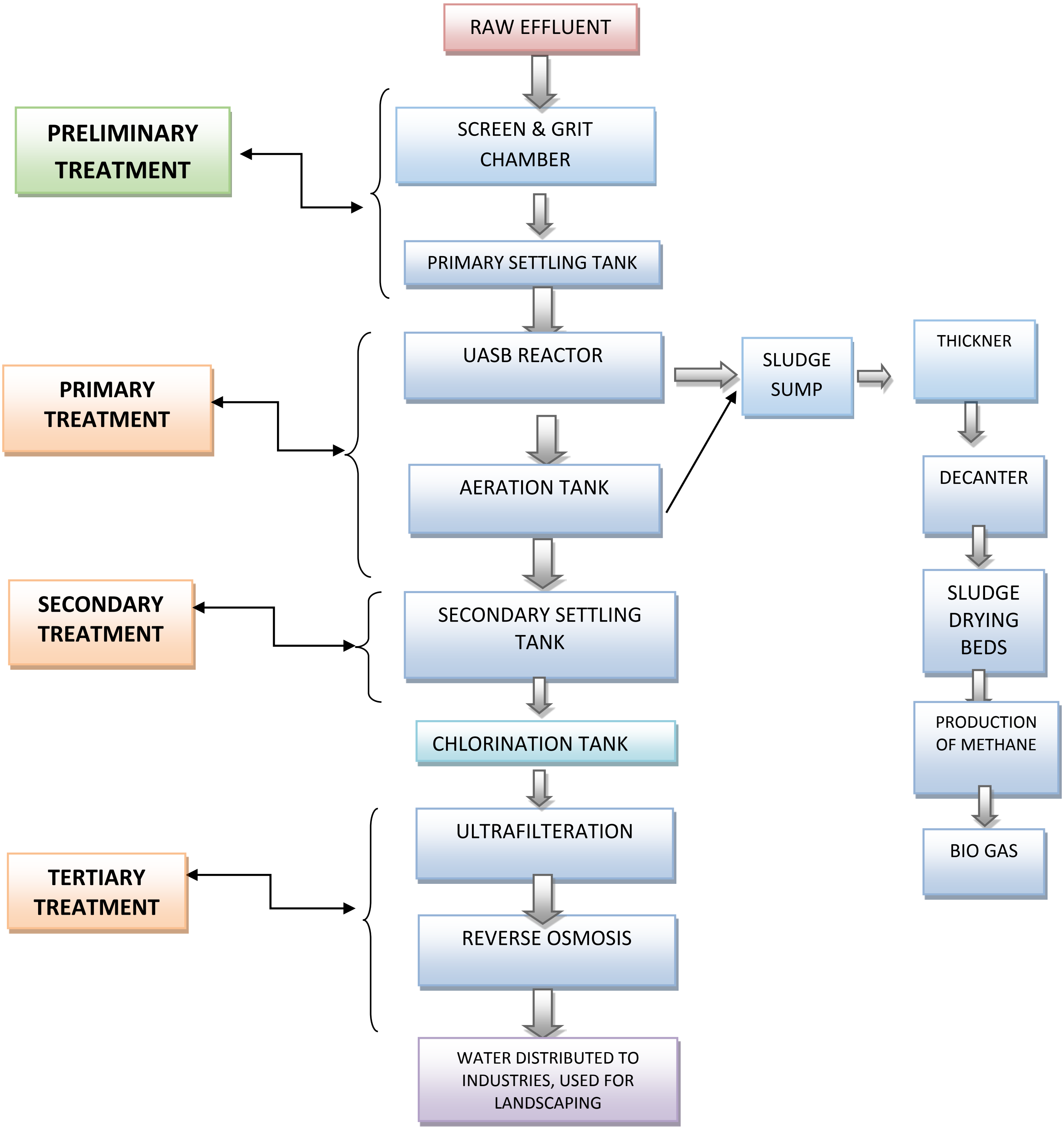
Present levels of pollutants in water bodies/effluent receiving drains/ground water (routine parameters, special parameters and water toxics relevant to the area in three categories – known carcinogens, probable carcinogens and other toxics). There are four effluent streams viz. Juinagar Nalla, Alok Nalla, Nocil Nalla and Airoli Nalla, and the creek water monitoring points at Airoli Bridge and Vashi Bridge.

Table 3.2 Results of Water Quality in Nallas Monitored by MPCB (2012):

Sr. No.	**Location**	**pH**	**SS mg/L**	**BOD mg/L**	**COD mg/L**
1	**Airoli**	**7.1**	**47**	**7.1**	**386**
2	**Nocil**	**7.1**	**47**	**7.1**	**348**
3	**Alok**	**7**	**64**	**7**	**156**
4	**Juinagar**	**7.1**	**62**	**7.1**	**116**

Source: http://cpcb.nic.in/divisionsofheadoffice/ess/NaviMumbai.pdf

Alternative Treatment Process



Systems added

Up flow Anaerobic Sludge Blanket Reactor (USAB)
Ultrafiltration
Reverse Osmosis

Costs involved:

- Construction Cost of UASB

Design of UASB for 27 MLD: 4710 cu.m.

Cost of RCC construction / cu.m. (labour + material) : Rs 26,000/cu.m.
Cost of construction of UASB for 27 MLD: 4710 cu.m. x 26,000
: **Rs 12, 24, 60,000**

- Cost of Ultrafilteration and Reverse Osmosis systems.

Cost of Ultrafilteration system for 27 MLD : Rs 15,00,000
Cost of Reverse Osmosis system for 27 MLD : Rs 30,00,000
Total Cost of Installation : **Rs 45,00,000**

- Operation & Maintenance of the UF & RO systems.

O&M cost for UF /cu.m. for 27 MLD : Rs 3/cu.m./day = Rs 81,000/ day
= **Rs 24,30,000/ month**
O&M cost fpr RO /cu.m. for 27 MLD : Rs 7/cu.m./day = Rs 1/ day
= **Rs 24,30,000/ month**

Comparative Cost Analysis of both processes:

Details	Present Treatment Cost/month (Rs.)	Alternative Treatment Cost/month(Rs.)	Alternative Treatment Cost + Cost of Recycling water /month (Rs.)
Pumping Cost	21,00,000	21,00,000	21,00,000
Aeration Costs	14,00,000	4,20,000	4,20,000
Chemical Costs	40,000	0	0
Ultrafilteration Costs	0	0	24,30,000
Reverse Osmosis Costs	0	0	56,70,000
Total Cost	**35,40,000**	**25,20,000**	**1,06,20,000**

Total cost with present treatment : **Rs 35,40,000 for 27 MLD**
Total Cost to Industry with Alternative treatment: **Rs 1,01,10,000 for 27 MLD**
Total Cost for Aternative treatment and recycling water: **Rs 1,06,20,000 for 27 MLD**

Cost of water to industries: **Rs 56/cu.m.**(for private sector , BMC)
: 27000 m^3 x 56 x 30
: **Rs. 4,53,60,000 / month**

Cost of Water after treatment: Rs 1,06,20,000/ month
Cost benefit from Alternative treatment
Production of methane
COD Input: 27000kg
0.35l / gm of COD
Considering 50 % of the total 27000 kg : 0.175l/gm : 4725m^3
Density = 0.66kg/m^3
Per day generation of Methane: 3118 kg

CONCLUSION & FUTURE SCOPE OF WORK

The current treatment process of CETP,TTC is not sustainable, and since it carries out processes for 3000 odd Small scale and Medium scale industries, it is necessary to adopt sustainable options, this benefiting the Environment, Society and the Economy. The alternative technologies mentioned in the study have been introduced to cut down on various impacts being generated from the CETP. The costs analyzed of the current system include high energy costs and chemical costs that are reduced in the alternative treatment process, but involves an investment cost which can be recovered since the cost to industries are quite high. The alternate process along with further treatment of the water treated can be beneficial, in terms of the water generated instead of pumping it to the water sources. The recycling of water involves investment costs that can be recovered in the near future. The recycled water can be used for landscaping, car washing, sold to industries for boilers.
An Environmental Impact Assessment can be conducted of the CETP, suggesting the total impacts of a

treatment plant. This will help MIDC to present such modules of CETP for all industrial areas in India, and further adoption of these strategies to achieve Sustainable working of Common Effluent treatment plants