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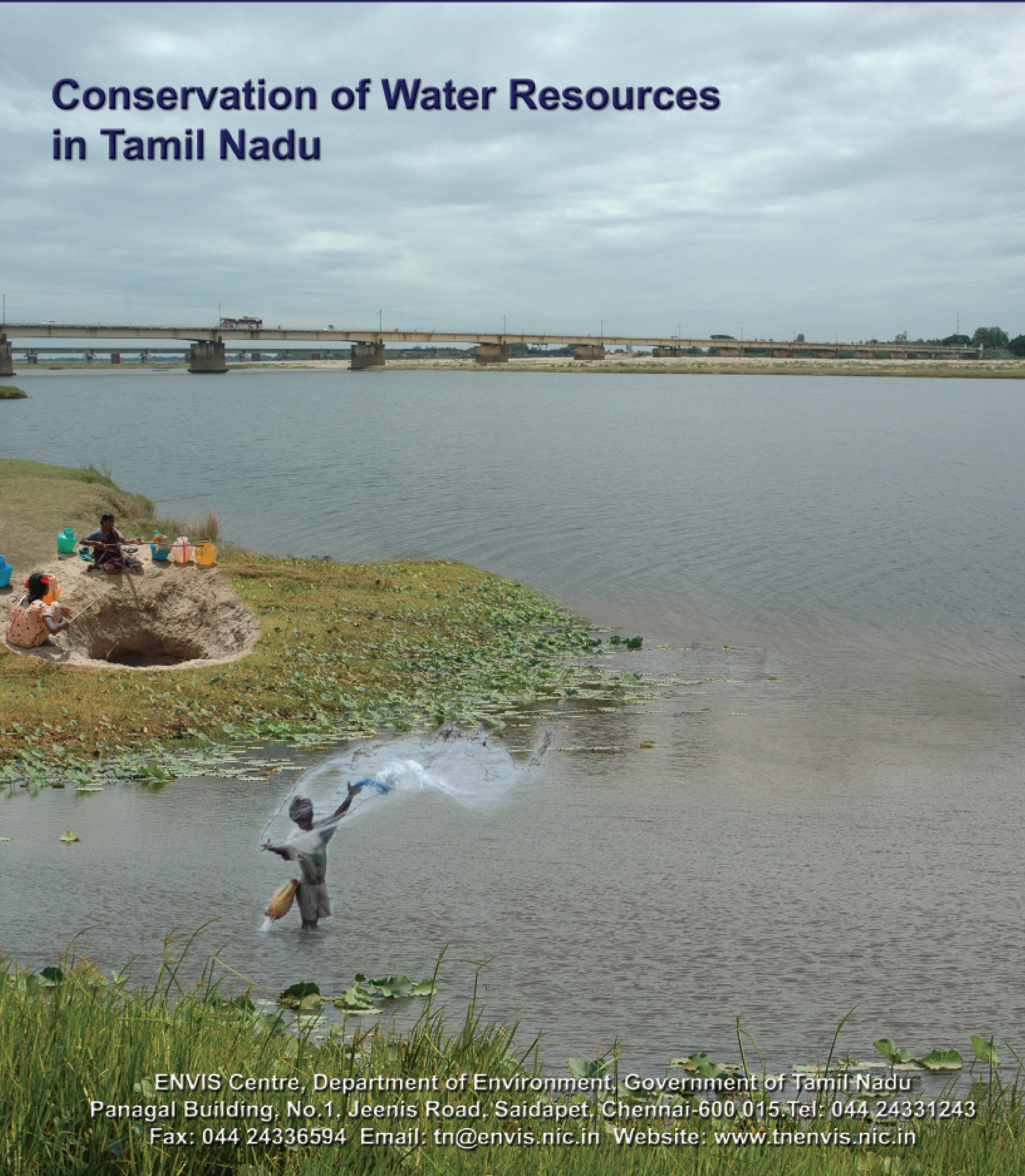
Conservation of Water Resources in Tamil Nadu



ENVIS Centre, Department of Environment, Government of Tamil Nadu
Panagal Building, No.1, Jeenis Road, Saidapet, Chennai-600 015.Tel: 044 24331243
Fax: 044 24336594 Email: tn@envis.nic.in Website: www.tnenvis.nic.in

CONSERVATION OF WATER RESOURCES IN TAMIL NADU

INTRODUCTION:

There are 17 major River basins in Tamil Nadu. The major rivers are Cauvery, Vaigai and Tamiraparani. Western Ghats form the major water catchment area. Water is mainly used for irrigation, domestic uses and Industrial purposes. Environmental concerns are Industrial effluent discharge, surface water pollution, ground water pollution, catchment degradation, siltation in rivers and reservoirs, excessive surface and ground water extraction, eutrophication and aquatic weeds. High altitude lakes like Ooty, Kodaikanal and Yercaud are major attraction of tourism. Cooum and Adayar are two small rivers flowing through the Chennai city which are highly polluted by urbanisation.

National River Conservation Plan (NRCP), launched by the Ministry of Environment and Forests (MoEF) in 1993, is under implementation in 160 towns along the polluted stretches of 34 rivers spread over 20 states. The objective of the NRCP is to check pollution in rivers through implementation of various pollution abatement activities.

National Lake Conservation Plan (NLCP) is being implemented by MoEF since 2001 for conservation and management of polluted and degraded lakes in urban and semi-urban areas.

I. Abatement of Pollution in five polluted stretches of River Cauvery

This is a centrally sponsored scheme under National River Conservation Programme at an overall project cost of Rs.36.28 crores and is being implemented since1996-1997 for abatement of pollution in five polluted stretches of River Cauvery. A sum of Rs.22.66 crores has been spent by the implementing agencies. Under Core activities, interception and diversion as well as sewage treatment plants are being implemented through the Tamil Nadu Water Supply and Drainage Board in Erode, Bhavani, Komarapalayam, Pallipalayam and Tiruchi towns. All the works in Tiruchi, Komarapalayam and Erode have been completed. The works in Bhavani are under progress. A revised Detailed Project Report for Pallipalayam is being prepared by the TWAD Board. Under Non-core activities, construction of low cost sanitation facility, crematoria and river front development have been completed by the local bodies.

Cauvery

II. National River Conservation Programme – Seven Additional Towns

Pollution abatement in the rivers Cauvery, Vaigai and Tamiraparani along seven towns viz., Tiruchi-Srirangam, Thanjavur, Kumbakonam, Karur-Inam karur, Mayialaduthurai, Madurai and Tirunelveli at a total cost of Rs.575.30 crores is under implementation. The grant from Government of India for this project is Rs.282.15 crores and the rest is being met by Government of Tamil Nadu, the local bodies concerned and through public participation.

Vagai river

The project envisages provision of underground sewerage systems, sewage treatment plants, low cost sanitation and solid waste management in these towns. These integrated projects will not only clean the river but also provide better health and hygiene to the people. Non-core schemes consist of solid waste management, low cost sanitation and river front development works which are being implemented by local bodies. By implementing this project 249.55 MLD of sewage can be effectively treated. The core works in Madurai and Kumbakonam are being implemented by Chennai Metro Water Supply and Sewerage Board. The works in respect of Karur, Mayiladuthurai, Thanjavur, Tiruchi and Tirunelveli are being implemented by Tamil Nadu Water Supply and

Drainage Board. The interception and diversion works under Phase IV in respect of Madurai will be implemented by Public Works Department. An amount of Rs.460.24 crores has been spent towards this scheme. The Underground Sewage System at Tirunelveli had been completed and is being maintained by Tirunelveli Corporation. Additional works are to be taken up in Mayiladuthurai and Thanjavur towns at a cost of Rs.253.70 lakhs.The additional work in Karur town at a cost of Rs 295.00 lakhs is under progress.


Tamiraparani

III. Chennai City River Conservation Project (CCRCP)

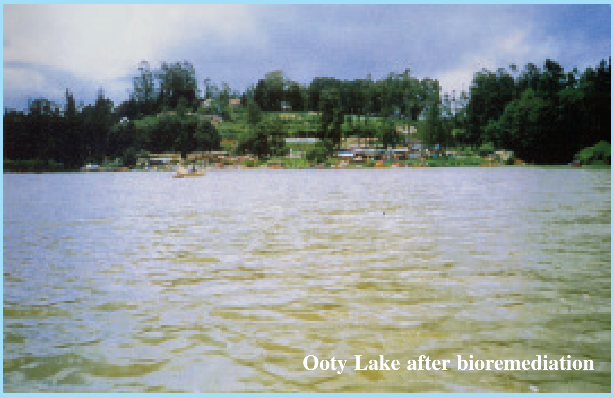
CCRCP is a project with Government of India grant of Rs.491.52 crores for pollution abatement in six important Chennai City Waterways viz., Cooum, Buckingham Canal, Adyar, Otteri Nullah, Captain Cotton Canal and Mambalam drain and is being implemented by Chennai Metropolitan Water Supply and Sewerage Board. The important component of the project is to intercept the sewage outfalls joining the six Chennai City Waterways and pumping it to the sewage treatment plants at Perungudi (54 MLD), Koyambedu (60 MLD), Nesapakkam (40 MLD) and Kodungaiyur (110 MLD). By completing this project, an additional quantity of 264 MLD of sewage is being treated by Chennai Metropolitan Water Supply and Sewerage Board. The expenditure incurred is Rs.380.46 crores. Additional works are being taken up under Chennai City River Conservation Project for Rs.2215.78 lakhs to further strengthen the city sewerage scheme.


Adyar river

IV. National Lake Conservation Programme (NLCP)

Revival of Ooty Lake has been completed at a cost of Rs.1.72 crores by Public Works Department and for this purpose, deweeding, desilting and bio-remediation have been done. The revised Detailed Project Report for Kodaikanal Lake has been sanctioned for Rs10.42 crores. It includes providing underground sewarage system and construction of sewage treatment plant by Tamil Nadu Water Supply and Drainage Board. Deweeding and bioremediation of the lake will be taken up by Public Works Department and low cost sanitation works by Kodaikanal Municipality. A sum of Rs.234.00 lakhs has been spent by the implementing agencies. Detailed Project Report for the revival of Yercaud Lake in Salem district has been prepared by Tamil Nadu Water Supply and Drainage Board for Rs.5.74 crores and has been sent to National River Conservation Directorate for approval.


Cleaning of Ooty Lake

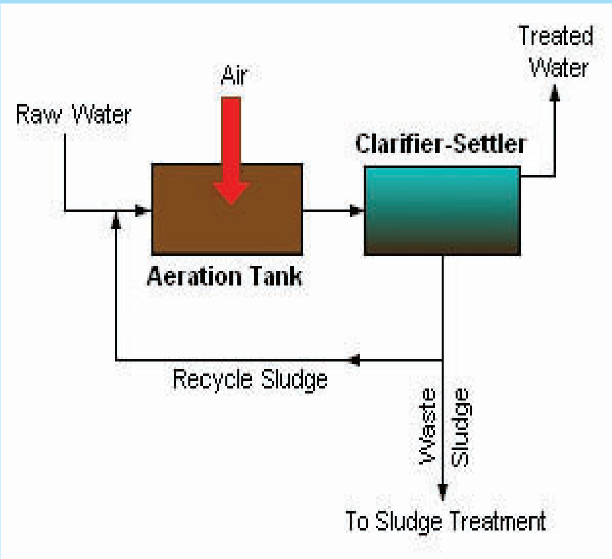

Ooty Lake after bioremediation


Kodaikanal lake

SEWAGE/ WASTEWATER TREATMENT TECHNOLOGIES:

I . Activated Sludge Process

The most common suspended growth process used for municipal wastewater treatment is the activated sludge process. The removal of BOD is done by a biological process, such as the suspended growth treatment process. This biological process is an aerobic process and takes place in the aeration tank, where in the wastewater is aerated with oxygen. By creating good conditions, bacteria will grow fast. The growth of bacteria creates flocks and gases. These flocks will be removed by a secondary clarifier. In the activated sludge process, the dispersed-growth reactor is an aeration tank or basin containing suspension of the wastewater and microorganisms, as a mixed liquor. The contents of the aeration tank are mixed vigorously by aeration devices which also supply oxygen to the biological suspension. Aeration devices commonly used include submerged diffusers that release compressed air and mechanical surface aerators that introduce air by agitating the liquid surface. Hydraulic retention time in the aeration tanks usually ranges from 3 to 8 hours but can be higher with high BOD wastewaters. Following the aeration step, the microorganisms are separated from the liquid by sedimentation. A portion of the biological sludge is recycled to the aeration basin to maintain a high mixed-liquor suspended solids (MLSS) level. The remainder is removed from the process and sent to sludge processing to maintain a relatively constant concentration of microorganisms in the system. Several variations of the basic activated sludge process, such as extended aeration and oxidation ditches, are in common use, but the principle is similar.



Activated sludge process

CETP at Koyambedu

II. Upflow Anaerobic Sludge Blanket (UASB) Process

UASB is an anaerobic process which forms a blanket of granular sludge and is suspended in the tank. Wastewater flows upwards through the blanket and is processed by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket begins to reach maturity at around 3 months. Small sludge granules begin to form whose surface area is covered by aggregations of bacteria. In the absence of any support matrix, the flow conditions create a selective environment in which only those microorganisms, capable of attaching to each other, survive and proliferate. Eventually the aggregates form into dense compact biofilms referred to as granules.

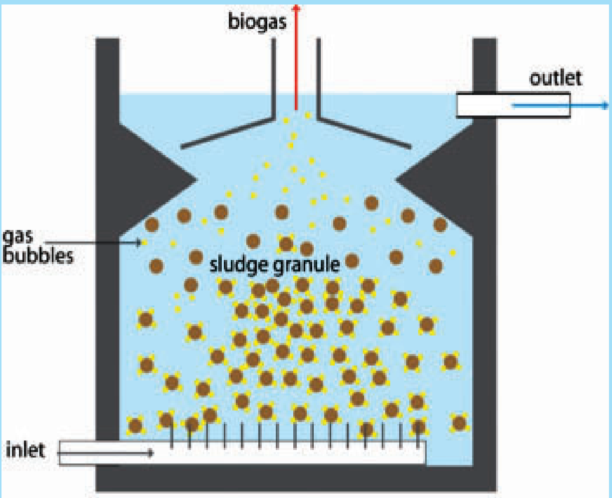
How does the UASB Work?

Fine granular sludge blanket acts as a filter to prevent the solids in the incoming wastewater to flow through as the liquid part does. So if the hydraulic retention time (HRT) does not change, which is limited to 1-3 days (the bigger the digester, the shorter time it is, because the size costs money), the solid retention time (SRT) can be 10-30 days or more for more effective digestion, depending on the shape of the digestion chamber. It means that the digester becomes much more efficient without having to increase the size, which costs money. Wageningen University in the Netherlands has started to do R & D along these lines. Standing and hanging baffles are used. Conical separation with a small outlet at the center will be much more effective to keep the anaerobic sludge blanket in the lower part of the digester. This will act as a very good filter to retard the flow of solids in the wastes and prolong the solid retention time for more bacterial action. However, the digester will be more economical if the loading can be increased for a specific size of digester with the conical separation. COD reduction of 58% obtained is adequate, and no attempt should be made to increase the bacterial action. It is better to use much cheaper open tanks and basins for more effectiveness and efficiency. Bio-chemical activities in USAB Digesters are in 3 phases and they occur in sequence

1. **Hydrolysis or solubilization** - The first phase takes 10-15 days, and until the complex organics are solubilized, they cannot be absorbed into the cells of the bacteria where they are degraded by the endoenzymes;

2. **Acidogenesis or acetogenesis** - The result from stage one utilized by a second group of organisms to form organic acids;

3. **Methanogenesis** - The methane-producing (methanogenic) anaerobic bacteria then use the product of (2) to complete the decomposition process.



Upflow Anaerobic Sludge Blanket

III. Waste Stabilization Ponds for Wastewater Treatment

Waste water stabilization pond technology is one of the most important natural methods for wastewater treatment. Wastewater stabilization ponds are mainly shallow man-made basins comprising a single or several series of anaerobic, facultative or maturation ponds. The primary treatment takes place in the anaerobic pond, which is mainly designed for removing suspended solids, and some of the soluble element of organic matter (BOD). During the secondary stage in the facultative pond most of the remaining BOD is removed through the coordinated activity of algae and heterotrophic bacteria. The main function of the tertiary treatment in the maturation pond is the removal of pathogens and nutrients (especially nitrogen). Waste stabilization pond technology is the most cost-effective wastewater treatment technology for the removal of pathogenic micro-organisms. The treatment is achieved through natural disinfection mechanisms. It is particularly well suited for tropical and subtropical countries because the intensity of the sunlight and temperature are key factors for the efficiency of the removal processes.

Water treatment in waste stabilization ponds

(a) Anaerobic ponds

These units are the smallest of the series. Commonly they are 2-5 m deep and receive high organic loads equivalent to100 g BOD/m^3. These high organic loads produce strict anaerobic conditions (no dissolved oxygen) throughout the pond. In general terms, anaerobic ponds function much like open septic tanks and work extremely well in warm climates. A properly designed anaerobic pond can achieve around 60% BOD removal at 20° C. One-day hydraulic retention time is sufficient for wastewater with a BOD of up to 300 mg/l at temperatures higher than 20° C. Designers have always been preoccupied by the possible odour they might cause. However, odour problems can be minimised in well designed ponds, if the SO_4 concentration in wastewater is less than 500 mg/l. The removal of organic matter in anaerobic ponds follows the same mechanisms that takes place in any anaerobic reactor.

(b) Facultative ponds

These ponds are of two types: primary facultative ponds receive raw wastewater, and secondary facultative ponds receive the settled wastewater from the first stage (usually the effluent from anaerobic ponds). Facultative ponds are designed for BOD removal on the basis of a low organic surface load to permit the development of an active algal population. This way, algae generate the oxygen needed to remove soluble BOD. Healthy algae populations give water a dark green colour but occasionally they can turn red or pink due to the presence of purple sulphide-oxidising photosynthetic activity. This ecological change occurs due to a slight overload. Thus, the change of colouring in facultative ponds is a qualitative indicator of an optimally performing removal process. The concentration of algae in an optimally performing facultative pond depends on organic load and temperature, but is usually in the range 500 to 2000 ìg chlorophyll per litre. The photosynthetic activity of the algae results in a diurnal variation in the concentration of dissolved oxygen and pH values. Variables such as wind velocity have an important effect on the behaviour of facultative ponds, as they generate the mixing of the pond liquid. A good degree of mixing ensures a uniform distribution of BOD, dissolved oxygen, bacteria and algae, and hence better wastewater stabilization.

(c) Maturation ponds

These ponds receive the effluent from a facultative pond and its size and number depend on the required bacteriological quality of the final effluent. Maturation ponds are shallow (1.0-1.5 m) and show less vertical stratification, and their entire volume is well oxygenated throughout the day. Their algal population is much more diverse than that of facultative ponds. Thus, the algal diversity increases from pond to pond along the series. The main removal mechanisms especially of pathogens and fecal coli forms are ruled by algal activity in synergy with photo-oxidation. On the other hand, maturation ponds only achieve a small removal of BOD, but their contribution to nitrogen and phosphorus removal is more significant. Nitrogen removal of 80% in all waste stabilization pond systems, corresponds to 95% ammonia removal. It should be emphasised that most ammonia and nitrogen is removed in maturation ponds. However, the total phosphorus removal in WSP systems is low, usually less than 50%.

Operation and maintenance

Before starting up the system, once the construction has been completed it should be checked that all ponds are free of vegetation. This is very important if the waste stabilization pond is not waterproof. Facultative ponds should be filled prior to anaerobic ponds to avoid odour release when anaerobic pond effluent discharges into an empty facultative pond . Anaerobic ponds should be filled with raw wastewater and seeded whenever possible with bio-solids from another anaerobic reactor. Later, the anaerobic ponds can be gradually loaded up to the design's loading rate. This gradual loading period can be from one to four weeks depending on the quality of the digester used or in case the pond was not seeded during the start-up procedure. It is important to measure the pH in the anaerobic pond and maintain it above 7 to permit the development of the methanogenic bacterial population. During the first month it may be necessary to add lime, to avoid the acidification of the reactor. Initially, facultative and maturation ponds should be filled with freshwater from a river, lake or well, so as to permit the gradual development of the algal and heterotrophic bacterial population. If freshwater is unavailable, facultative ponds should be filled with raw wastewater and left for three to four weeks to allow the aforementioned microbial populations to develop. A small amount of odour release is inevitable during the implementation of the latter method in the facultative pond.

Routine maintenance

Once the waste stabilization ponds have started to operate, it is necessary to carry out regular routine maintenance tasks. Although simple, these tasks are essential for proper operation of the system.

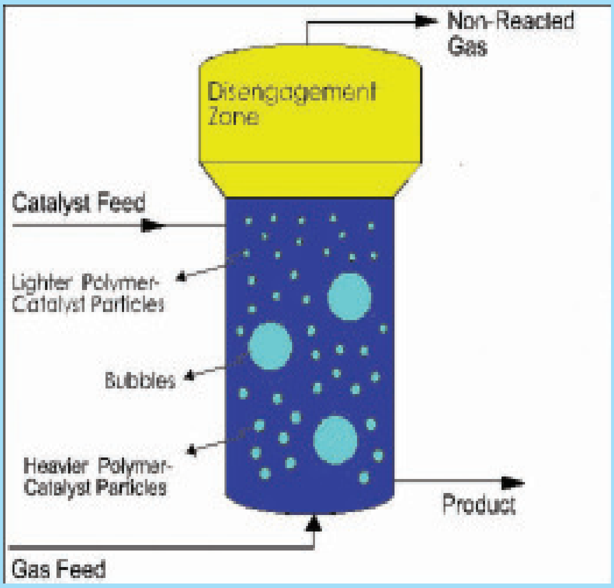
- Removal of screening and grit retained in the inlet works during the preliminary treatment.
- Cutting, pruning and removing the grass and vegetation that grows on the embankment to prevent it from falling into the pond and formation of mosquito breeding habitats. The use of slow-growing grass or vegetation is recommended to minimise the frequency of this task.
- Removal of floating scum and macrophytes (e.g. *Lemna* spp.) from facultative and maturation ponds to maximise photosynthesis and surface re-aeration, and prevent fly and mosquito breeding.
- Spraying the scum on the surface of anaerobic ponds (which should not be removed as it aids the treatment process). If fly breeding is detected this material should be sprayed with clean water.
- Removal of any accumulated solids in the pond's inlets and outlets.
- Repair of any damage to the embankments caused by rodents or other animals.
- Repair of any damage to external fences and gates or points of access to the system.

The operator responsible should register these activities in a pond maintenance record sheet. Usually this operator is also in charge of taking samples and measurements of the pond's effluent flow.

IV. Fluidized Bed Reactor

Aerobic fluidized bed reactors (FBRs) are used as a new technology in wastewater treatment. An aerobic Fluidized Bed Reactor with granulated activated carbon (GAC) as carrier material can be operated under different conditions, including batch-loading, semi continuous loading, and continuous loading. The basic idea behind the Fluidized Bed Reactor is to have a continuous operating non-clogging bio film reactor which requires (1) no back-washing, (2) has low head loss and (3) high specific bio film surface area. This is achieved by having the biomass to grow on small carrier elements that move with the liquid in the reactor. The movement within the reactor is generated by aeration in the aerobic reactor. These bio-film carriers are made of special grade plastic with density close to that of water.

The Fluidized Bed Reactor employs fixed film principle and makes the treatment process more user friendly because it does not require sludge recycle i.e. synonymous with conventional ASP. The absence of sludge recycle frees the operator from the enormous task of measurement and monitoring MLSS levels in the tank and adjusting recycle rations continuously, due to fluctuating inlet BOD loads. FBR produces small quantity of sludge which requires no further treatment. Fluidized Bed Reactor technology is used in small Sewage Treatment Plants for treating city wastewater, industrial sewage treatment plant from food waste, paper waste and chemical waste etc. Due to fixed film nature, these plants accept shock loads much better than those employed for suspended growth process. Fluidized Bed Reactors are generally tall (6 m and above), thereby reducing cross-sectional area further.



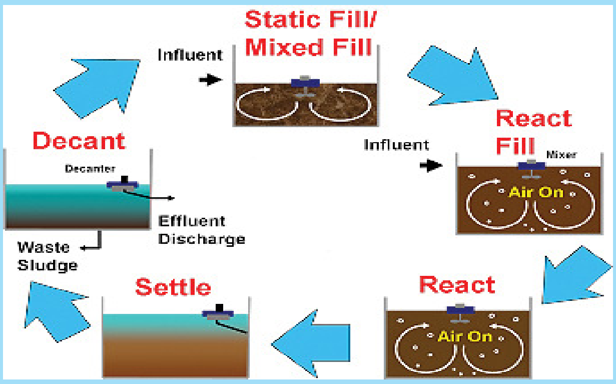
Fluidized Bed Reactor

V . Sequential Batch Reactor

In this process, the raw sewage free from debris and grit shall be taken up for biological treatment for removal of organic, nitrogen and phosphorus. The activated sludge bio-system is designed using Advanced Cyclic Activated Sludge Technology which operates on extended aeration activated sludge principle for the reduction of carbonaceous BOD, nitrification, denitrification as well as phosphorus removal using energy efficient fine bubble diffused aeration system with automatic control of air supply based on oxygen uptake rate. In this form, the sequences of fill, aeration, settle and decant are consecutively and continuously operated all in the same tank. No secondary clarifier system is required to concentrate the sludge in the reactor. The return sludge is recycled and the surplus is wasted from the basin itself. The complete biological operation is divided into Fill – Aeration, Settlement and Decanting.

These phases in a sequence constitute a cycle. During the period of a cycle, the liquid volume inside the Reactor increases from a set operating bottom water level. During the Fill-Aeration sequence mixed liquor from the aeration zone is recycled into the selector. Aeration ends at a predetermined period of the cycle to allow the biomass to flocculate and settle under quiescent conditions. After a specific setting period, the treated supernatant is decanted, using a moving weir decanter. The liquid level in the reactor is so returned to bottom water level after which the cycle is repeated. Solids are separated from the reactor during the decanting phase. The system is capable of achieving the following:

i) Bio-degradation of organics present in the wastewater by Extended Aeration Process.
ii) Oxidation of sulphides in the wastewater
iii) Co-current nitrification and denitrification of ammonical nitrogen in the aeration zone.
iv) Removal of phosphorous



Sequential Batch Reactor

Cooum restoration project

The initial phase would involve providing sewerage system for town and village panchayats and municipality at a cost of about Rs 200 crore, strengthening the existing sewage system for prevention of sewage flow into Cooum at a cost of Rs 117 crore and improvement of the river front at a cost of Rs 200 crore. Steps will also been taken for the improvement of 71 tanks in the upstream area falling in Tiruvallur and Kancheepuram districts and continuous dredging of river mouth. As environmental and social enhancement measures, it is proposed to provide river walk, boating for recreational/tourist/commercial purposes, Cooum park and museum and events such as water sports to generate revenues and maintain interest in the river.

The Tamil Nadu government has signed a memorandum of understanding with Singapore Cooperation Enterprise (SCE) to promote and facilitate cooperation and collaboration in restoration, beautification and management of the Cooum river. The State government had formed Chennai River Restoration Trust (CRRT) with the mandate to restore rivers and water bodies in Chennai

Rapid Environment Assessment of Kodaikanal Lake:

Kodaikanal Lake is in the Palni Hills at an altitude of 2,285 m at 10°14' N latitude and 77°28' E longitude. The Lake which forms the heart of the resort is star shaped, covering an area of about 24 hectares. It was created in 1863 by Sir Hendry Levinge and in 1910 a new boathouse was constructed. The boat service was opened to the public and tourists in 1932. Since then Kodaikanal has been the most popular hill station of South India. A Rapid Environmental Assessment study of the Kodaikanal Lake was carried out by the ENVIS team to assess the physico-chemical and biological quality of the lake water. To assess the water quality status, five important parameters namely pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Coliforms and Fecal Coliforms were assessed. Water sample were collected from 4 different locations with the help of the Kodaikanal municipality.