CONSTRUCTED WETLAND BASED TECHNOLOGY FOR SUSTAINABLE SEWAGE / WASTEWATER TREATMENT: Phytorid - SWAB

1 Preamble

More than, 70,000 MLD wastewater is generated in urban India comprising Class I and Class II cities. About 30% installed treatment capacity, but only about 10% gets treated across the country. Similarly, only 60% of industrial waste water, mostly large scale industries, is treated. Total untreated sewage is almost 70 percent of total sewage generated, and is generally discharged in nearby water sources. Municipal wastewater treatment has been normally carried out by conventional systems. These systems along with advanced technologies being employed at many places are highly dependent upon power availability, skilled manpower and waste load characteristics. In developing countries, some of these could be critical towards efficient waste treatment. These factors are also responsible for varying degree of treatment efficiency that may not produce the desirable levels of standards prescribed by the regulatory agencies/authorities.

Thus, it is important to demand of time to develop a sustainable wastewater treatment system overcoming the above-mentioned limitations of the conventional wastewater treatment technologies. One such system is Phytorid Technology based on “re- engineered” wetlands systems to solve the current runoff and wastewater quality problems.

Natural wetlands have been used to treat wastewater for hundreds of years. Formal documentation of how these natural wetlands affected wastewater quality began in the 1960s and 1970s. Research found consistent reductions in the pollutant concentrations of wastewater, as it passed through the microbial active wetlands. And by the late 1970s and early 1980s, this research led to the planning, development, and construction of discharges to natural wetlands at many locations in North America, as well as the implementation of wetland technology for both habitat and water quality functions.

Various drawbacks such as clogging, insufficient treatment, huge land requirement and cost have not allowed this technology to gain widespread acceptance as a wastewater treatment technology.

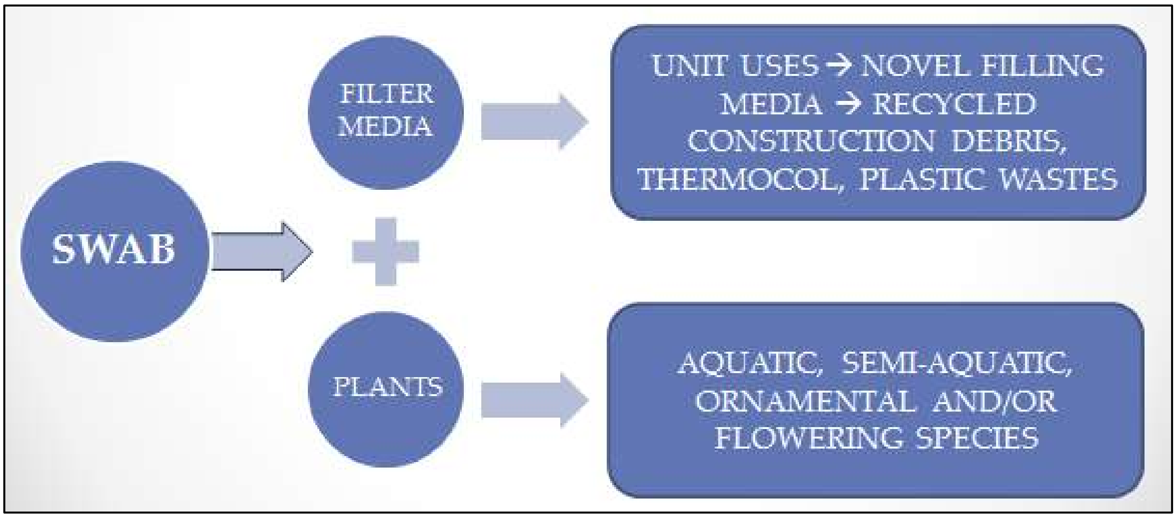
Phytorid - Scientific Wetland with Active Biodegradation (SWAB) is an upgradation of the existing technological concepts with respect to Indian climatic conditions and negates all the above mentioned drawbacks. Basically it is a hybrid of MBBR (Moving Bed Biofilm Reactor) systems and Phytorid wastewater treatment system with much enhanced hydrodynamic flow regime. A major requirement of this technology is being felt in the country right now as all the existing STP's have (by law) to be upgraded to meet the new regulation of discharge standards of 10mg/L BOD and 20mg/L TSS. Existing technological options make this upgradation prohibitively expensive but with SWAB the same can be achieved in a much more economical manner.

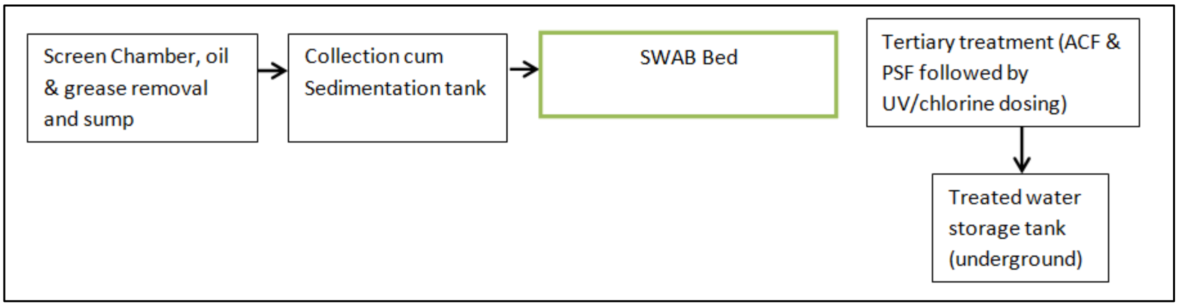
Phytorid Technology is a self-sustaining technology developed by CSIR-National Environmental Engineering Research Institute (NEERI) that works on the principles of natural wetland. It has been developed and patented by (CSIR-NEERI). **The patent awarded is European Patent Office (EPO) Pub. No.: WO2004087584, Pub. Date: 14.10.2004, Australian Patent Office (APO) Pub. No.: AU2003223110, Pub. Date: 25.10.2004 and Indian Patent Office (IPO) 0010NF2003/IN Pub. No.: 241523, Pub. Date: 09/07/2010.** This technology has also obtained authorization from the Council of Scientific and Industrial Research.

2 Description of Technology

Phytorid - SWAB systems are based on natural treatment methods such as filtration, sedimentation, nutrient uptake by plants and microbial action in a constructed system which is filled with novel filling media. Specifically identified different species of plants which are known to have good nutrient uptake rates are planted in the SWAB bed.

- SWAB is essentially a civil structure. These are constructed as shallow basins or channels with a subsurface barrier to avoid seepage.
- The SWAB Technology is a subsurface flow type wherein water is applied to the cells/ beds filled with porous media such as gravel and stones.
- The hydraulics is maintained in such a manner that water does not rise to the surface retaining a free board at the top of the filled media.
- The flow of wastewater is 6 inch below the top gravel layer and therefore no sewage is exposed thereby escaping mosquito problems.





General Layout of Phytorid-SWAB wastewater treatment plant

2.1 Screen Chamber, Oil & Grease Removal System and Sump

Solid waste in the wastewater is separated by using bar screens of 5 mm and 3 mm aperture size. Oil and fat removal is combined next to it so that the collection and equalization tank can function properly. Wastewater is then pumped using a sump into the sedimentation tank.

2.2 Collection-Cum-Sedimentation Tank

The specified design (as shown in figure below) of collection-cum-sedimentation system allows suspended solids to settle down in the tank and achieve simultaneous removal of BOD (by more than fifty per cent). This would require no pH adjustment and clarification system to remove settled solids if domestic wastewater treatment is being targeted.

2.3 Phytorid - SWAB BED

PRINCIPLE: The SWAB bed works on the principle of sequential aerobic and anoxic treatment.

To achieve better efficiency of treatment, the SWAB bed is divided into compartments with baffles provided in such a way that the flow of wastewater is in sinusoidal manner. This unique baffle and wall arrangement – (i) Increases the contact time of microbes and the plant roots. (ii) Provides alternate aerobic and anoxic phases in the same reactor leading to SBR type operations in the same SWAB bed.

This unit uses novel filling media (recycled construction debris, thermocol, choir and plastic wastes- either in combination or singly) thereby reducing capital cost and also recycling waste products. Also, locally available material can be used.

The SWAB Bed is sown with semi-aquatic, aquatic, ornamental, flowering species of plants. Aerobic zone is near roots of the plants, as plants transports oxygen from air to the roots and in-turn into water for biochemical oxidation. The plants in the SWAB bed uptake nitrates and phosphates from the wastewater.The importance of plant species in the treatment system is not only the direct uptake and enzymatic degradation of the pollutants but also act as a support for the microbes that remain active around the rhizosphere area that are defined as those portions of the root profile that give rise to new growth from the plant. The plant systems act as oxygen diffusers via uptake through the leaves and its transfer through the stem to the roots. Thus, it creates staggered septic and aseptic zones for enhanced microbial growth and activity. These systems may include a wide variety of foliage in the form of aquatic, marsh, ornamental, herbs, grasses and also terrestrial plants known to grow in water logged conditions.

- Colocasiaesculenta, Canna indica, Cyperusalternifolius, Yellow Cana
- Red Cana, Pampas Grass, Cyperus Spp., Spider Lily, Canna Verigated
- Typha spp., Soft Rush / Bull Rush Spp., Elephant Ear
- Phragmitesaustralis / spp.

Due to several passages through gravel beds with both aerobic and anaerobic zones faecal coliform is also reduced by more than 99%. SWAB requires much less electricity and fewer skilled operators for its operation (these are the major O&M cost in any STP) but still is able to achieve either better or nearly similar pollutant removal as compared to any other STP processes.

2.4. Tertiary Treatment System

Activated Carbon Filter (ACF) & Pressure sand filter (PSF) followed by UV/chlorine dosing. Also TiO_2 coating can be opted for if the end requirement (recycle& reuse) of treated water demands it.

2.5 Treated Water Storage Tank

It is the underground collection tank for water coming from the planted bed after treatment.

Table 1: Treatment efficiency of Phytorid system

Pollutant	Performance (% removal)
Total suspended solids	75-95
Biochemical oxygen demand (BOD)	80-93
Chemical oxygen demand	85-95
Total nitrogen	60-70
Phosphate	30-40
Faecal Coliform	90-95

3 PROPOSED APPLICATIONS:

For the treatment of wastewater generated in the form of:

- Municipal/ Domestic wastewaters
- Commercial establishments
- Agricultural runoffs
- Storm water runoffs

4 ADVANTAGES OF TECHNOLOGY

- Negligible consumption of electric power.
- The technology is very simple in design and operation therefore needs no skilled manpower for operation and maintenance.
- The system has an aesthetic aura because of plants (ornamental as well as flowering) and subsurface flow of water
- Negligible sludge production
- No odour
- No application of chemicals for treatment process
- Lower costs of treating water
- Happier nearby residents
- Increased development and preserved values of property proximal to STP
- More diverse biota
- Increased presence of birds and other fauna
- Extra gardens and landscaping features not required for beautification
- Carbon sequestration

5 LIMITATIONS OF THE TECHNOLOGY

- Power is required.
- Periodic Operation and Maintenance must be performed.
- Land requirement is high compared to MBBR and MBR.

6 OPERATION AND MAINTENANCE:

This technology being a natural system, operation is mostly passive and requires little operator intervention.

- Maintaining uniform flow across the wetland system through inlet and outlet adjustment is extremely important to achieve the expected treatment performance.
- Operational aspects include harvesting of the roots once 6 months and loosening of the gravel after a year.
- Any accumulation of sludge due to non-removal at the first stage will need flushing, for washing the gravel bed for further use.
- Sampling of inlet and outlet will be carried out for a period of 3 months every fortnight after stabilization of the treatment systems.

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