Phytorid Technology for Treatment of Sewage

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A huge quantity of sewage is generated in rural and urban areas. With limited installed capacity of treatment in centralised manner, a large portion of this sewage remains untreated and left as it is to water bodies. Currently there is a growing awareness of the impact of sewage contamination on rivers and lakes. In order to rejuvenate the rivers and lakes it is extremely necessary to stop the flow of untreated waste from river basin to the rivers. A large portion of the wastewater is domestic sewage.

In order to make the method feasible selection of technology for sewage treatment should be on criteria such as plant which works without electricity, require minimum maintenance and most importantly, the technology should be self-sustainable. In order to use the technology in rural areas these criteria become more important due to lack of skilled manpower and challenges on electrical supply. This necessitates use of natural methods, which are highly efficient and structured. Using this concept, natural wetland functioning has been used to design a technology wherein wetlands plants and combined working of their root system have been integrated to get a designer ecosystem. National Environmental Engineering Research Institute (NEERI) has developed a novel technology based on natural method of treatment of sewage using constructed wetlands. The technology is named as PHYTORID and is well patented nationally and internationally.

What is PHYTORID system

Engineered wetland system can be used for treatment of wastewater and particularly for treatment of sewage. This is a stand-alone technology and is very effective alternative to conventional activated sludge treatment plants. PHYTORID is a subsurface flow constructed wetland system (SSFCW) with successful demonstration in the field for more than 6 years of continuous operation as a stand alone sewage treatment system.

The porous media also supports the root structure of emergent vegetation. The design of the Phytorid system assumes that the water level in the cells will remain below the top of the filter media. The vegetation to be utilized for the said Phytorid system is very important. Various species of aquatic plants have been utilized to attain maximum efficiency in the treatment of domestic wastes. These include species like Phramites australis, Phalaris arundinacea, Glyceria maxima, Typha spp., Scirpus spp., other common grasses etc.

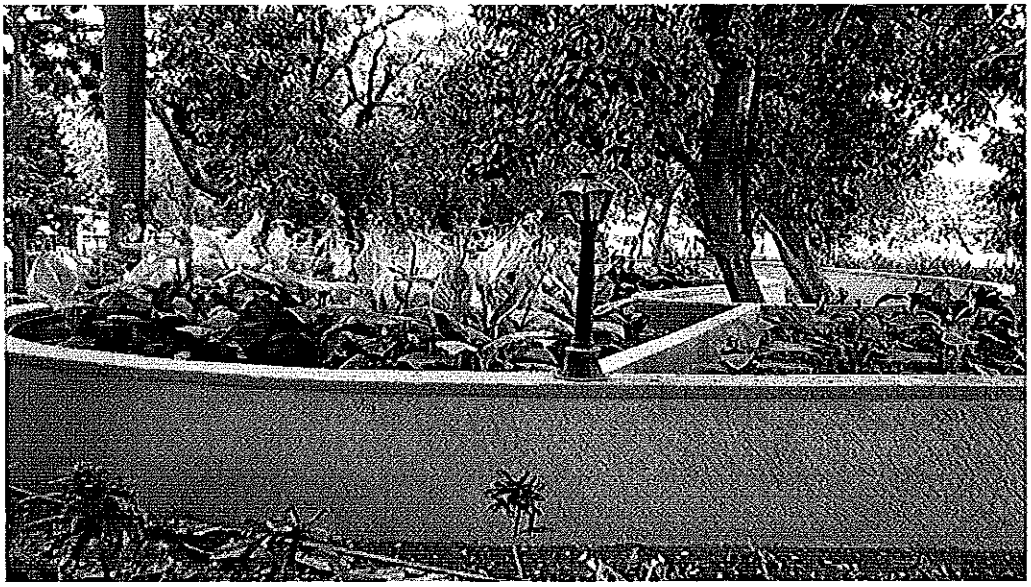
Advantages of PHYTORID System

The PHYTORID systems have distinct advantages over conventional treatment plants. The technology is recommended for decentralized plants with varying capacities of 5000 L/day to 8-10 MLD. The best feature of the PHYTORID technology is that are no mechanical or electrical machineries such are aerators are involved. This gives an advantage for sustainable operation of PHYTORID.

Several advantages of PHYTORID are as follows;

- **No mechanical or electrical machineries** such as aerators/pumps are involved therefore **very low maintenance** (about 10% of Activated Sludge treatment plant or even less as compared to Membrane technology).
- **Space saving** technology as compared to other no-electricity (passive) systems such as Wastewater Stabilization Ponds (WSP). One day residence time for Phytorid as compared to 10-18 days for WSP
- **Scalable** from individual household to community to village/township level
- Decentralized system thereby **saving cost on sewage pipelines** and avoids loss by leakages
- Treated water quality **meets discharge and irrigation standards** specified by CPCB. If ozonation (based on solar power) is added then it meets all reuse standards.
- Aesthetic improvements as **Phytorid resembles garden** (Photo shown below)
- Due to subsurface flow design, **no mosquitoes and odor nuisance** as compared to some other surface flow technologies
- Systems are able to tolerate fluctuations in flow
- They facilitate water reuse and recycling

- They provide habitat for many wetland organisms
- This is also more desirable in areas with high water table to avoid any contamination of ground water through soak pit
- It can be applied preservation of natural watercourses such as lakes, rivers and marine ecosystem
- It can be easily integrated into the natural topography



Photograph of a PHYTORID based sewage treatment system emphasising aesthetic view of the plant

PHYTORID working in the field

There are about more than 35 PHYTORID systems with varying capacities from 2000 L/day to 1 MLD are working in the filed successfully for treatment of sewage. The first ever plant was installed at Mumbai University, Kalina campus in 2006.

The PHYTORID technology owing to its several advantage on technological features and economical basis has a large potential for decentralised treatment of sewage in urban and rural areas of the country with concomitant advantage of water resource conservation.

Table 1: Select list of Phytorid Systems installed.

Sr. No.	Place	Capacity (m^3/day)
1.	Primer Auto Ltd, Pune	150
2.	Siemens Ltd Kalwa	500
3.	Bharat Forge, Baramati	100
4.	MJP, Nabi Lake Lonar, Maharashtra	500
5.	Mahindra Vehicle Manufactures, Chakan	750
6.	Swapnalok Builders, Pune (under construction)	250
7.	Clover, Vascon Builder, Pune (under construction)	550
8.	Municipal Council, Chandur Railway	100
9.	Municipal Council, Dhamangao	100
10.	Municipal Council, Daryapur	100
11.	Dr. Panjab Rao Deshmukh Krishi Vidyapeeth, Nagpur	100

Performance of PHYTORID

Table 2: Typical Performance of PHYTORID system on inlet and outlet parameters

Parameter	Inlet (Sewage)	Outlet (treated Water) after Phytorid bed	Outlet after Solar based Ozonation step	Standards as per Environment Protection Rules, 1986	
				Disposal to Inland Surface Water	Disposal on Land for irrigation
BOD (mg/L)	80 to 300	<30	<10	30	100
COD (mg/L)	200 to 600	< 100	<50	250	Not Specified
Total Suspended Solids (ppm)	100 to 500	< 100	<30	100	200
Ammonia as NH3 (ppm)	5 to 20	< 5.0	<5.0	5.0	Not Specified
Phosphate	10 to 50	< 5.0	< 5.0	5.0	Not Specified
pH	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5-9.0	5.5-9.0
Colour	Black/dark	Colourless	Colourless	Colourless	Colourless
Fecal Coli Farm (MNP/100ml)	10^6 to 10^7	<500	Nil	<500	<500

Space Requirement

As seen from the above photographs phytorid can be integrated into the landscape and therefore no dedicated space is required. However, the total area required for Phytorid treatment plant for a capacity of 100 m^3/day is approximately 150 m^2. The area does not include amenities, approach and other needs for maintenance, which could be an additional 10-20%. Based on the land availability and shape of the land, design can also be changed. If one or two pumps are used then tanks can be built in multiple levels and space can be saved.

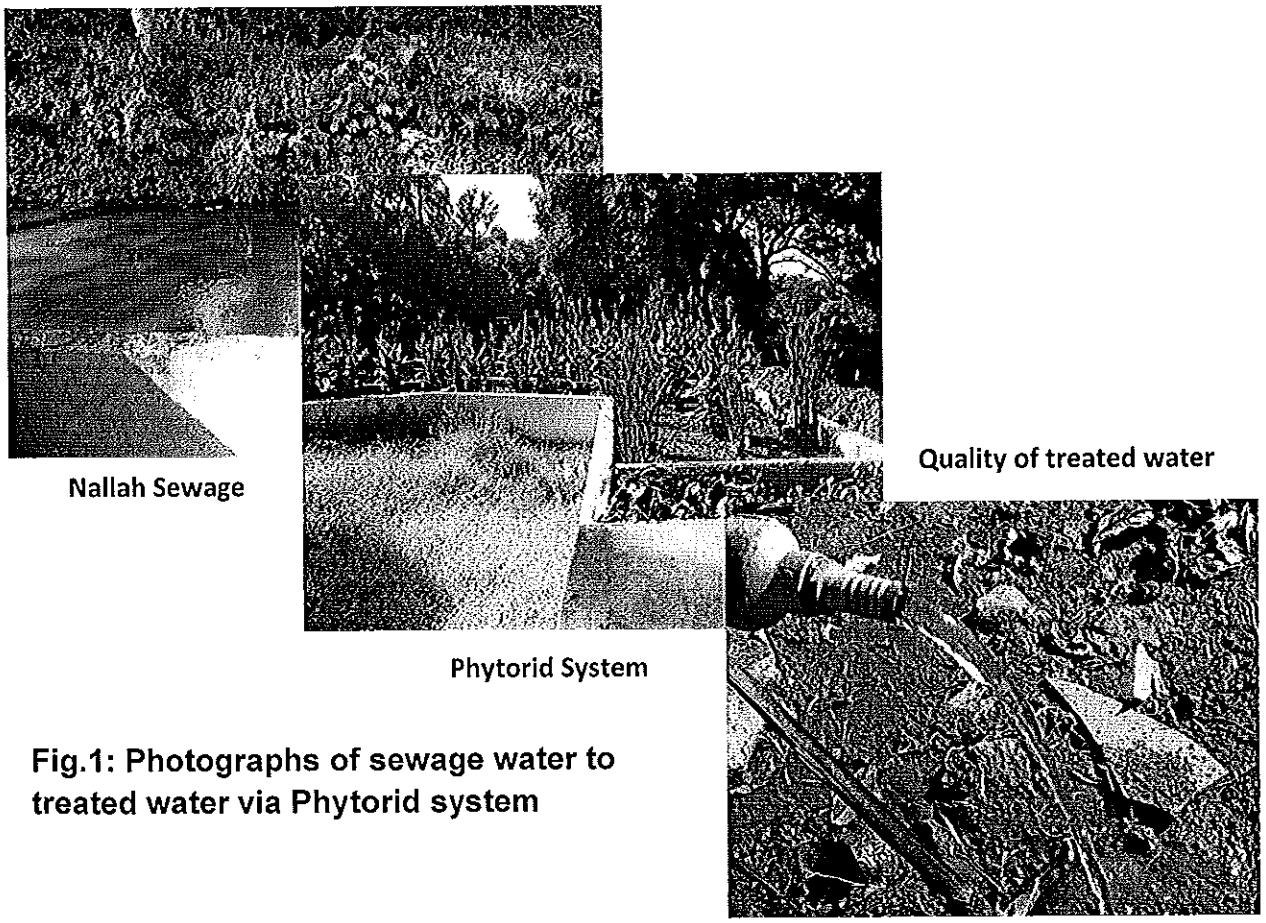


Fig.1: Photographs of sewage water to treated water via Phytorid system

Operation & Maintenance Schedule for Phytorid plant

Although no elaborate maintenance is required as compared to mechanised plants following operation and maintenance is required.

Periods in Months	1	2	3	4	5	6	7	8	9	10	11	12
O & M item												
Replantation (partial if needed)			O									O
Water Quality analysis	O	O	O		O		O		O			O
Cleaning of Screening Chamber [this could be every week, in case load of floating matter is high]	O	O	O	O	O	O	O	O	O	O	O	O
Harvesting of overgrown plants and roots			O			O			O			O
Hydraulics/ water level Checks						O						O
Cleaning of Settling chamber												O
Gravel checks and reshuffle						O						O
Pump maintenance (if pump is installed)			O			O			O			O
Biomedia augmentation (10% of the first time addition)												O

Applications of PHYTORID

The PHYTORID technology is best applicable to following;

- Domestic municipal sewage treatment
- Nallah water treatment
- Improving the lake water quality
- Industrial waste water particularly textile, dairy, food etc.

Capacity dependent Cost of PHYTORID

Phytorid system is a cost effective option for treatment of sewage from domestic sources. The installation cost of the complete system depends on the capacity of the plant. A variation in the cost of installation, maintenance cost of sewage treatment and space required is shown in the following table;

Population (with LPCD of 70)	Capacities, m^3/day	Civil costs# (for typical design)	Solar pumps*, pipes, etc	Bio-media Culture costs	Plantation costs	Annual Maintenance charges	NEERI's charges	Total Cost (Rs.)	Land Requirement (Sqm)
500	25	1141334	50000	58800	11116	72000	50000	13,83,250	30
600	35	1335135	50000	70560	13339	100800	50000	16,19,834	42
700	40	1506895	50000	82320	15562	115200	50000	18,19,977	48
800	45	1700740	50000	94080	17786	129600	50000	20,42,206	54
900	50	1872250	50000	105840	20009	144000	50000	22,42,099	60
1000	55	2066050	50000	117600	22232	158400	50000	24,64,282	66
1200	65	2437993	50000	141120	26678	187200	50000	28,92,991	78
1400	75	2798758	50000	164640	31125	216000	50000	33,10,523	90
1600	90	3164069	50000	188160	35571	259200	50000	37,47,000	108
1800	100	3536056	50000	211680	40018	288000	50000	41,75,754	120
2000	112	3901367	50000	235200	44464	322560	50000	46,03,591	134