Mini Review

Quality of sewage water and phytorid technology for its reuse in agriculture

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Introduction

Water requirement in India in the year 2025 is assessed at 1027 BCM as against the requirement of 525 BCM in the year 1990 showing an increase of 86 percent. Besides, India need to produce 380 MT of food grain per annum in 2025, against the present 242 MT, to feed 1.4billion expected population under resource constraints. The scope for increase in production through horizontal expansion of area is negligible and due to competition from other mere paying sectors of economy, the fresh water availability is bound to decrease for agriculture. According to the estimates, wastewater generated through irrigation, water supply, industry and energy sectors is expected likely to be 556 BCM by 2025 in India.[1] Thus utilization of water resources is crucial to agricultural production for meeting the ever-increasing demand of irrigation water in agriculture. Since natural water resources are limited and a large gap exists between available water supply and the amount required for intensive cropping, appropriate use of wastewater of domestic origin can help in meeting a part of the increased demand of water. Wastewater reuse for agriculture presents not only a low cost appropriate disposal medium but also an opportunity to manage wastes with minimum adverse environmental effects, as the treatment requirements prior to land application are less rigid than those for disposal into water bodies. It has been observed that in states, such as Haryana, the NO_3 concentration has exceeded the permissible limits.[2] Application of sewage, sludge and municipal wastewater on land has been practiced since time immemorial. The challenge is to utilize the physical, chemical, and biological properties of soils as an acceptor with minimum adverse effects on crops to be grown, soil characteristics and ground and surface water quality.[1] Such practice of sewage irrigation continues for longer period, without knowing pollutant load, this may lead to chemical degradation of lands and possible entry of pollutants/toxicants in the food chain of people and animal consuming the farm produce of these lands Oswald (1989). In view of this, it is necessary to assess and monitor the sewage water and treated sewage water used for irrigation of the agricultural crops otherwise there will be health hazards

Importance of the problem

Use of untreated sewage in agriculture is of public concern due to possible phyto-toxicity and/or incorporation of metal cat ions into the food gradients. Excess nitrogen and phosphorous in effluents can leach and pollute groundwater under continuous sewage effluent use for long periods.[3] The impact of long term use of poor quality water on soil health, groundwater pollution and food chain contamination is governed by water quality and site-specific soil, climate and crop conditions.[1] National Environmental Engineering Research Institute (NEERI), Nagpur has developed a novel technology based on natural method of treatment of sewage using constructed wetlands. Use of plant species along with their root system along with the natural attenuation processes can be combined together to get the Phytorid technology. It is one such technological solution, which can be easily implemented in cities as well as in rural areas for treatment of wastewater. The system is based on use of specific plants normally found in natural reed with filtration and treatment capability. This system can be utilized for a wide variety of applications. It can be used for secondary and tertiary treatment of municipal wastewater, sludge management, treatment of industrial or agricultural effluent as well as for the treatment of landfill leachates.

The national environmental policy recommends use of constructed wetland system for efficient sewage treatment.

Characteristics and quality of raw sewage water

The sewage water of 4 upstream locations were monitored monthly and analysed for the physico-chemical parameters. The total soluble salts and total dissolve solids have higher content in the month April, May and June whereas lower content were observed in other months and this might be due to dilution effect by surface runoff. TSS and TDS were well below the limit of Bureau of Indian Standard (BIS). The BOD and COD were higher in some time during the year and which was nearer or higher than B.I.S. The raw sewage water content ammoniacal and nitrate nitrogen and also posses' soluble phosphorus which are the major nutrient for growth. This water has fertigation effect on crops. The pH of water showed slightly acidic to slightly alkaline reaction. Electrical conductivity was higher in summer months than rainy and winter months. The higher EC waters are not safe for irrigating clay soils as the problem of salinity could be occur in long term. The micronutrients and heavy metals content in sewage water were below the safe limit. However the concentration of cadmium and chromium was very close to these limits having the chances of accumulation in soils if raw sewage is used for irrigation. Seasonal concentration of micronutrients like Zn, Fe and Cu in domestic sewage water is mainly due to rusting of metals, plumbing, wood preservatives, roof runoff, cosmetic material, construction material, fungicide etc. as given by Ibrahim et al.[4] The analysis of Zn, Fe and Cu in seasonal trend of sewage water showed concentration well below the standard limits given by BIS. However, Mn was found to be in higher Concentration than the safe limit, which can cause health hazards if the sewage water is used for irrigation for agricultural crops. Main sources of Mn were oil and lubricants. The results thus indicated that presence of higher concentration of Mn would be a restriction on the use of raw water for irrigation. Similarly, the concentration of heavy metal like Cd generated through rechargeable batteries, storm water, pesticides, gardening products was higher than the safe limit, and a restriction on the use of raw water. This may cause harmful effect on the vegetables and crops grown by utilizing this water for irrigation without secondary treatment.[4] However, Cogenerated through medicine, food products, ointments, paints and pigments was within permissible limit, and did not pose any restriction on direct use of the raw water (Table 1) (Table 2).

Heavy metals like Cr generated through phosphate fertilizers and metallurgic industries cause atmospheric deposition. It is also released by tanning, ink manufacture, metal plating, dyes, wood preserving, textile and ceramic industries.[5] The sources of Pb in the river water are cleaning products, fire extinguisher, lubricants, health supplement, oil and lubricant, paints and pigments, photo graphics, pesticides and gardening products, etc.. Their concentrations were within limits. Fecal collipresence in the river water was found to be more than 1100colliform per 100ml of water in all samples. With FAO recommendation of 100colliform per 100ml of water for safe irrigation, the present concentration in the river water does not permit its use for irrigation purposes.

Table 1 Physio-chemical parameters of sewage water of the nag river

Parameterr	TSS	TDS	BOD	COD	pH	EC	N	P
Month/Unit	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})	(mg L^{-1})		(d S/m)	(mg L^{-1})	(mg L^{-1})
June	30.4	366.45	47.48	175.11	6.78	0.59	1.55	0.6
July	30.4	324.42	24.8	94.75	7.31	0.24	1.61	0.6
Aug	14.15	293.56	102.87	395.74	7.16	0.22	2.75	0.84
Sept	16.33	319.97	88.35	350	7.26	0.26	2.76	0.95
Oct	11.91	319.72	53.27	194.92	7.16	0.26	2.87	1.03
Nov	12.62	303.62	18.1	68	7.08	0.48	3.16	1.11
Dec	13.9	314.11	52.37	196.82	7.08	0.52	3.3	1.15
Jan	13.48	296.93	53.62	197.26	7.11	0.59	2.46	0.34
Feb	17.38	296.82	68.55	221.24	7.14	0.6	2.09	0.44
March	15.98	310.51	71.85	257.91	7.29	0.6	1.92	0.46
April	23.32	335.02	83.06	285.34	7.3	0.69	2.06	0.44
May	33.59	360.53	41.41	178.18	7.04	0.71	1.7	0.58
Mean.	19.46	317.66	60.39	217.93	7.17	0.48	2.36	0.72
B.I.S	200	2100	100	250	6.5-8.5	0.75-2.25	45	10

Table 2 Monthly average spatial trend of concentration of micronutrients and heavy metals in the Nag river sewage water in year 2012-13 (June-12 – May-13) season

Parameter	unit	Safe limit	Plant inlet	Up stream.	RTO.office	Gokulpeth
Zn	mg L^{-1}	2	0.170	0.118	0.12	0.111
Fe	mg L^{-1}	5	0.160	0.135	0.129	0.130
Cu	mg L^{-1}	0.2	0.023	0.015	0.014	0.018
Mn	mg L^{-1}	0.2	0.220	0.17	0.24	0.233
Co	mg L^{-1}	0.05	0.012	0.009	0.009	0.013
Cd	mg L^{-1}	0.01	0.010	0.012	0.011	0.013
Cr	mg L^{-1}	0.1	0.008	0.006	0.008	0.009
Pb	mg L^{-1}	5.2	0.048	0.042	0.042	0.044

Sewage treatment plant

A simple solution for big problem

The main purpose of STP is to provide a simple, feasible, practically sound, eco-friendly, maintenance free and cost-effective technology, which can handle the sewage waste water treatment leading to reuse of treated water for purposes like gardening.

PHYTORID is a scientifically developed systematic treatment methodology for waste water

i. PHYTORID combines Physical, Biological and Chemical processes.

ii. Works on gravity

iii. No electric power requirement

iv. Scalable technology

v. Easy to maintain

vi. Adds to aesthetics

vii. Cost effective

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Typical design features

The general concept design for the Phytorid system can be modified as per specifications and land availability. The sub-surface flow type, Phytorid system is proposed for the treatment of sewage or domestic wastewater which will consists of a basin or a channel which a barrier to prevent seepage, but the systems\cells\ beds contain a suitable depth of porous media. A primary treatment facility would also be constructed along with basic for a effective removal of solids and thus reduces the marginal BOD. 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.[6] 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, Pahlavi's *arundinacea*, *glyceria maxima*, *Typha spp*, *Scirpus spp*, other common grasses etc.

Advantages of phytorid technology

i. Treatment efficiencies for the removal of faecal colliforms, BOD ,COD , Nutrients are up to 95 percent which is greater than traditional chemical methods

ii. It is very cost effective technology compared with the traditional waste water treatment method, since it utilizes the natural vegetation and rhizosphere, microorganism; it is eco-friendly method of treating sewage.

iii. The quality of treated water is comparable to irrigation standards[7] (Table 3).

Quality of treated water

i. The treated water will meet the quality suitable for gardening, washing, and flushing purpose. Treated water will also meet the discharge standards. Specified by Maharashtra Pollution Control Board (Table 4).

Table 3 Performance of phytorid for sewage water treatment

Pollutant	Performance (% removal)
Total suspended solids	75-95
Biochemical oxygen demand	70-80
Chemical oxygen demand	60-75
Total nitrogen	60-70
Phosphate	50-60
Fecal coli form	85-95

Table 4 Comparative study of the different methods of the sewage water treatments

Sr	Items	Conventional activated sludge	UASB	Extended aeration	Facultative Aerated Lagoons	Phytorid Technology
1	Performance BOD removal %	85-92	75-78	95-98	75-85	80-95
2	Sludge	First digest then dry on beds or use mech device	Directly dry on beds or use mech devices	No digestion dry on sand beds or use mech devices	Mech. Desludging once in 5-10years	Negligible
3	Land Requirement for 1MLD plant	4500m^2	3000m^2	5000m^2	5000m^2	2000m^2
4	Maintenance cost per year	10-15% of the plant cost	10-15% of the plant cost	3-5% of the plant cost	3% of the plant cost	1-2% of the plant cost, no mechanical or electrical component thus very low maintenance cost
5	Payback period if water is reused	About3-4 years	About 3-4 years	More than 5 years	More than 5 years	About 3-4 years
6	Equipment Requirement (excluding screening and grit removal common to all processes)	Aerators, recycle, pumps, scrappers , thickener, digesters,	Nil except gas collection	Aerations, recycle, pumps, sludge, scrappers for large settlers	Aerators only	None, all flows by gravity

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Conclusion

i. Pollution load of raw sewage water varies with the location and season.

ii. Use of raw sewage water for irrigation may cause soil and groundwater pollution problems.

iii. Treated sewage water through Phytorid Sewage treatment plant can safely utilized for the irrigation

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None.

Conflict of interest

The author declares no conflict of interest.

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