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***Research Paper***

# 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 1.4 billion 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 (Gupta, 2003). 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 (Maria 2003). 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 (Gupta *et al.*1998).

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 (Chaney, 1990). 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 (Mihnas and Gupta, 1992). 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 analyzed 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.

**Table 1. Physio-chemical parameters of sewage water of the Nag River; Nagpur**

| parameter | 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 | 30.40 | 366.45<br>352.3<br>288.53<br>339.30 | 47.48<br>51.47<br>34.930<br>54.110 | 175.11<br>222.5<br>143.57<br>214.90 | 6.78 | 0.59 | 1.55 | 0.6 |
| July | 30.40 | 324.42<br>339.4<br>289.53<br>351.70 | 24.8<br>29.13<br>17.690<br>29.460 | 94.75<br>114.7<br>68.330<br>104.33 | 7.31 | 0.24 | 1.61 | 0.6 |
| Aug | 14.15 | 293.56 | 102.87<br>82.03<br>115.60<br>131.92 | 395.74<br>308.3<br>443.33<br>517.00 | 7.16 | 0.22 | 2.75 | 0.84 |
| Sept | 16.33 | 319.97 | 88.35<br>82.93<br>84.230<br>91.330 | 350.00<br>299.7<br>306.00<br>445.33 | 7.26 | 0.26 | 2.76 | 0.95 |
| Oct | 11.91 | 319.72 | 53.27<br>40.92<br>32.75<br>114.89 | 194.92<br>151.7<br>119.67<br>410.33 | 7.16 | 0.26 | 2.87 | 1.03 |
| Nov | 12.62 | 303.62 | 18.10<br>14.44<br>7.80<br>20.270 | 68.00<br>54.00<br>29.67<br>74.670 | 7.08 | 0.48 | 3.16 | 1.11 |
| Dec | 13.90 | 314.11 | 52.37<br>49.71<br>37.49 | 196.82<br>187.3<br>141.67 | 7.08 | 0.52 | 3.30 | 1.15 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 72.370 | 274.67 | | | | |
| Jan | 13.48 | 296.93 | 53.62<br>58.57<br>45.50<br>63.000 | 197.26<br>213.7<br>158.00<br>244.67 | 7.11 | 0.59 | 2.46 | 0.34 |
| Feb | 17.38 | 296.82 | 68.55<br>70.08<br>83.21<br>66.070 | 221.24<br>238.3<br>200.00<br>247.00 | 7.14 | 0.60 | 2.09 | 0.44 |
| March | 15.98 | 310.51 | 71.85<br>78.70<br>67.67<br>65.030 | 257.91<br>286.0<br>241.67<br>232.33 | 7.29 | 0.60 | 1.92 | 0.46 |
| April | 23.32 | 335.02 | 83.06<br>89.22<br>74.77<br>79.470 | 285.34<br>305.7<br>260.00<br>267.33 | 7.30 | 0.69 | 2.06 | 0.44 |
| May | 33.59 | 360.53 | 41.41<br>24.33<br>95.00<br>20.670 | 178.18<br>111.0<br>424.33<br>77.330 | 7.04 | 0.71 | 1.70 | 0.58 |
| Mean. | 19.46 | 317.66 | 60.39<br>58.83<br>54.694<br>71.629 | 217.93<br>207.7<br>211.35<br>259.15 | 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 |

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 and Salaman (1992).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

**Table 3. 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**

| Paramete | Unit | Safe | Plant Inlet | Up Stream. | RTO.office | Gokulpeth |
|---|---|---|---|---|---|---|
| Zn | mg $L^{-1}$ | 2.0 | 0.170 | 0.118 | 0.120 | 0.111 |
| Fe | mg $L^{-1}$ | 5.0 | 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 | 0.170 | 0.240 | 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 |

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 (Ibrahim and Salamon, 1992; Kahlown *et al.,* 2006). 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.
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 (Thornton *et al.,* 2006). 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 colli* presence in the river water was found to be more than 1100 colliform per 100 ml of water in all samples. With FAO recommendation of 100 colliform per 100 ml of water for safe irrigation, the present concentration in the river water does not permit its use for irrigation purposes.

**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 which combines Physical, Biological and Chemical processes. The system works on gravity.

**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.

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**

Treatment efficiencies for the removal of faecal colliforms, BOD ,COD , Nutrients are up to 95 percent which is greater than traditional chemical methods. 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. The quality of treated water is comparable to irrigation standards

**Table 4. 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 |

**Quality of treated water:** 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 5. 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 5-10 years | Negligible |
| 3. | Land Requirement for 1MLD plant | 4500 $m^2$ | 3000$m^2$ | 5000 $m^2$ | 5000 $m^2$ | 2000 $m^2$ |
| 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 |

## Conclusion

Pollution load of raw sewage water varies with the location and season.Use of raw sewage water for irrigation may cause soil and groundwater pollution problems. Treated sewage water through Phytorid Sewage treatment plant can safely utilized for the irrigation.

**REFERENCE**

Thornton I; Butler D; Docx P; Hession M; Makro- poulos C; McMullen M; Nieuwenhuijsen M; Pitman A; Rautiu R; Sawyer R; Smith S; White D. 2001. Pollutants in urban wastewater and sewage sludge, Final Report, European Union, London. pp. 1-244.

Gupta, A. P., R. P. Narwal and R. S. Antil, 1998. Sewer water composition and its effect on soil properties. Bio-resource Ethnology 65: 171-173.

Maria, A. (2003), 'The Costs of Water Pollution in India', paper presented at the conference on Market Development of Water & Waste Technologies through Environmental Economics, 30–1 October 2003, Delhi.

M. Ibrahim and S. Salamon, "Chemical Composition of Faisalabad City Sewage Effluent: II Irrigation Quality," *Journal of Agriculture Research*, Vol. 30, No. 1, 1992, pp. 391-340.

A. M. Kahlown, M. Ashraf, M. Hussain, A. H. Salam and Z. A. Bhatti, "Impact Assessment of Sewerage and Indus- trial Effluents on Water Resources, Soil, Crops and Hu- man Health in Faisalabad," Pakistan Council of Research in Water Resources, Lahore, 2006, pp. 1-105.

Anonymous, 2005. Phytorid technology: A natural technique for municipal and industrial waste water treatment, International patented technology, Technical folder, National Environmental Engineering Research Institute, Nagpur

Hamid, Almas., M. Zeb, A. Mehmood, S. Akhtar and S. Saifm, 2013. Assessment of wastewater quality of drains for irrigation. J. of Environmental Protection, 4:937-945